ALFRED NORTH WHITEHEAD

AN ANTHOLOGY

Murray Library
Lake Erie College
Painesville, Ohio

SIGILLUM · COLLEGII · LACUS · ERIENSIS
Ps XC 17
1856

Alfred North Whitehead

AN ANTHOLOGY

THE MACMILLAN COMPANY
NEW YORK · CHICAGO
DALLAS · ATLANTA · SAN FRANCISCO

THE MACMILLAN COMPANY
OF CANADA, LIMITED
TORONTO

Alfred North Whitehead

AN ANTHOLOGY

Selected by

F. S. C. NORTHROP AND MASON W. GROSS

INTRODUCTIONS AND A NOTE ON WHITEHEAD'S TERMINOLOGY
BY MASON W. GROSS

MURRAY LIBRARY
LAKE ERIE COLLEGE
PAINESVILLE, OHIO

THE MACMILLAN COMPANY—*New York* · *1953*

COPYRIGHT, 1925, 1926, 1927, 1929, 1933, 1938, 1953,
by THE MACMILLAN COMPANY

All rights reserved—no part of this book may be reproduced in any form without permission in writing from the publisher, except by a reviewer who wishes to quote brief passages in connection with a review written for inclusion in magazine or newspaper.

First Printing

Printed in the United States of America

MURRAY LIBRARY
LAKE ERIE COLLEGE
PAINESVILLE, OHIO

Acknowledgment is hereby made to the Cambridge University Press for kind permission to reprint An Enquiry Concerning the Principles of Natural Knowledge, The Concept of Nature, and The Principle of Relativity with Applications to Physical Science; to the Royal Society and the Cambridge University Press for kind permission to reprint On Mathematical Concepts of the Material World; and to the University of Virginia for kind permission to reprint Symbolism, Its Meaning and Effect.

192.9
N81

CONTENTS

On Mathematical Concepts of the Material World 7

The Aims of Education and Other Essays 83
Chapters I, IV, V, VII, VIII

An Enquiry Concerning the Principles of Natural Knowledge 155
Chapters I, II, III, IV

The Concept of Nature 197
Chapters I, II, III, IV, V, VII

The Principle of Relativity with Applications to Physical Science 295
Preface, Chapters I, II, III, IV

Science and the Modern World 359
Chapters I, II, III, IV, V, VI

Religion in the Making 467
Chapters I, II, III, IV

Symbolism, Its Meaning and Effect 529
Chapters I, II

Process and Reality: An Essay in Cosmology 563
Part I, Chapters I, II, III; Part II, Chapters I, II, III, IV, V, VI

Adventures of Ideas 747
Part I, Chapter VI, Epilogue; Part II, Chapters VII, VIII; Part III, Chapters XI, XII, XIII, XIV, XV

Modes of Thought 857
Lectures Five, Six, Seven, Eight, Nine

Whitehead's Terminology
by Mason W. Gross 925

43581

On Mathematical Concepts of the Material World

ON MATHEMATICAL CONCEPTS OF THE MATERIAL WORLD

The first major work published by Whitehead was his Treatise on Universal Algebra. Volume One of this work was published in the year 1898, and was the only volume published. During the succeeding twenty years Whitehead published a number of books and articles, mostly in the field of mathematics and mathematical logic. Among them we may list The Axioms of Projective Geometry (1906), The Axioms of Descriptive Geometry (1907), and An Introduction to Mathematics (1911). In the years 1910, 1912, and 1913 respectively there appeared the three volumes of Principia Mathematica, of which Bertrand Russell was the coauthor.

The editors have decided against including any of these mathematical writings in this anthology of Whitehead's philosophy, in spite of the enormous importance of Whitehead's work in these fields. However, there is one paper which is not readily accessible to students of Whitehead, and which represents an important early stage in the development of his philosophy. Entitled "On Mathematical Concepts of the Material World," it was read before the Royal Society in London on December 7, 1905, and was published in the Philosophical Transactions of the Royal Society in 1906. It is reprinted here in its entirety for the first time.

PREFACE

The object of this memoir is to initiate the mathematical investigation of various possible ways of conceiving the nature of the material world. In so far as its results are worked out in precise mathematical detail, the memoir is concerned with the possible relations to space of the ultimate entities which (in ordinary language) constitute the 'stuff' in space. An abstract logical statement of this limited problem, in the form in which it is here conceived, is as follows: Given a set of entities which form the field of a certain polyadic (i.e., many-termed) relation R, what 'axioms' satisfied by R have as their consequence, that the theorems of Euclidean geometry are the expression of certain properties of the field of R? If the set of entities are themselves to be the set of points of the Euclidean space, the problem, thus set, narrows itself down to the problem of the axioms of Euclidean geometry. The solution of this narrower problem of the axioms of geometry is assumed (cf. Part II, Concept I) without proof in the form most convenient for this wider investigation. But in Concepts III, IV, and V, the entities forming the field of R are the 'stuff,' or part of the 'stuff,' constituting the moving material world. Poincaré* has used language which might imply the belief that, with the proper definitions, Euclidean geometry can be applied to express properties of the field of any polyadic relation whatever. His context, however, suggests that his thesis is, that in a certain sense (obvious to mathematicians) the Euclidean and certain other geometries are interchangeable, so that, if one can be applied, then each of the others can also be applied. Be that as it may, the problem, here discussed, is to find various formulations of axioms concerning R, from which, with appropriate definitions, the Euclidean geometry issues as expressing properties of the field of R. In view of the existence of change in the material world, the investigation has to be so conducted as to introduce, in its abstract form, the idea of time, and to provide for the definition of velocity and acceleration.

The general problem is here discussed purely for the sake of its logical (i.e., mathematical) interest. It has an indirect bearing on philosophy by disentangling the essentials of the idea of a material world from the

* Cf. *La Science et l'Hypothèse*, Chap. III, at the end.

accidents of one particular concept. The problem might, in the future, have a direct bearing upon physical science if a concept widely different from the prevailing concept could be elaborated, which allowed of a simpler enunciation of physical laws. But in physical research so much depends upon a trained imaginative intuition, that it seems most unlikely that existing physicists would, in general, gain any advantage from deserting familiar habits of thought.

Part I (i) consists of general considerations upon the nature of the problem and the method of procedure. Part I (ii) contains a short explanation of the symbols used. Part II is devoted to the consideration of three concepts, which embody the ordinary prevailing ideas upon the subject and slight variants from them. The present investigation has, as a matter of fact, grown out of the *Theory of Interpoints*, which is presented in Part III (ii), and of the *Theory of Dimensions* of Part IV (i). These contain two separate answers to the question: How can a point be defined in terms of lines? The well-known definition* of the projective point, as a bundle of lines, assumes the descriptive point. The problem is to define it without any such assumption. By the aid of these answers two concepts, IV and V, differing very widely from the current concepts, have been elaborated. Concept V, in particular, appears to have great physical possibilities. Indeed, its chief difficulty is the bewildering variety of material which it yields for use in shaping explanations of physical laws. It requires, however, the discovery of some appropriate laws of motion before it can be applied to the ordinary service of physical science.

The Geometry throughout is taken to be three-dimensional and Euclidean. In Concept V the definition of parallel lines and the 'Euclidean' axiom receive new forms; also the 'points at infinity' are found to have an intimate connection with the theory of the order of points on any straight line. The *Theory of Dimensions* is based on a new definition of the dimensions of a space.

The main object of the memoir is the development of the *Theory of Interpoints*, of the *Theory of Dimensions*, and of *Concept V*. The other parts are explanatory and preparatory to these, though it is hoped that they will be found to have some independent value.

* Here in 'Descriptive Geometry' straight lines are open, and three collinear points have a non-projective relation of order; in 'Projective Geometry' straight lines are closed, and four collinear points have a projective relation of separation.

PART I (i) *GENERAL CONSIDERATIONS*

Definition.—The *Material World* is conceived as a set of relations and of entities which occur as forming the 'fields' of these relations.

Definition.—The *Fundamental Relations* of the material world are those relations in it, which are not defined in terms of other entities, but are merely particularized by hypotheses that they satisfy certain propositions.

Definition.—The hypotheses, as to the propositions which the fundamental relations satisfy, are called the *Axioms* of that concept of the material world.

Definition.—Each complete set of axioms, together with the appropriate definitions and the resulting propositions, will be called a *Concept of the Material World.*

Definition.—The complete class of those entities, which are members of the fields of fundamental relations, is called the class of *Ultimate Existents.* This technical name is adopted without prejudice to any philosophic solution of the question of the true relation to existence of the material world as thus conceived.

Every concept of the material world must include the idea of time. Time must be composed of *Instants* (cf. Bertrand Russell, 'Mind,' N.S., Vol. 10, No. 39). Thus *Instants of Time* will be found to be included among the ultimate existents of every concept.

Definition.—The class of ultimate existents, exclusive of the instants of time, will be called the class of *Objective Reals.*

The relation of a concept of the material world to some perceiving mind is not to be part of the concept. Also we have no concern with the philosophic problem of the relation of any, or all, of these concepts to existence.

In Geometry, as derived from the Greeks, the simple elements of space are *points*, and the science is the study of the relations between points. Points occur as members of the fields of these relations. Then matter (the ultimate 'stuff' which occupies space) in its final analysis, even if it is continuous, consists of entities, here called *particles*, asso-

ciated with the points by relations which are expressed by saying that a particle *occupies* (or *is at*) a point. Thus matter merely occurs as one portion of the field of this relation of occupation; the other portion consists of points of space and of instants of time. Thus 'occupation' is a triadic relation holding in each specific instance between a particle of matter, a point of space, and an instant of time. According to this concept of a material world, which we will call the *Classical Concept*, the class of ultimate existents is composed of three mutually exclusive classes of entities, namely, *points of space*, *particles of matter*, and *instants of time*. Corresponding to these classes of entities there exist the sciences of *Geometry*, of *Chronology*, which may be defined as the theory of time considered as a one-dimensional series ordinally similar to the series of real numbers, and of *Dynamics*. There appears to be no science of matter apart from its relations to time and space.

Opposed to the classical concept stands Leibniz's theory of the Relativity of Space. This is not itself a concept of the material world, according to the narrow definition here given. It is merely an indication of a possible type of concepts alternative to the classical concept. It is not very obvious how to state this theory in the precise nomenclature here adopted. The theory at least means that the points of space, as conceived in the classical concept, are not to be taken among the objective reals. But a wider view suggests that it is a protest against dividing the class of objective reals into two parts, one part (the space of the classical concept) being the field of fundamental relations which do not include instants of time in their fields, and the other part (the particles) only occurring in the fields of fundamental relations which do include instants of time. In this sense it is a protest against exempting any part of the universe from change. But it is not probable that this is the light in which Leibniz himself regarded the theory. This theory, though at present it is nominally the prevailing one, has never been worked out in the form of a precise mathematical concept. It is on this account criticized severely by Bertrand Russell (cf. *loc. cit.* and 'Philosophy of Leibniz,' Cambridge, 1900, p. 120), who, however, has gone further than any of its upholders to give it mathematical precision. Of course, from the point of view of this paper, we are not concerned with upholding or combatting any theory of the material world. Our sole purpose is to exhibit concepts not inconsistent with some, if not all, of the limited number of propositions at present believed to be true concerning our sense-perceptions.

Definition.—Any concept of the material world which demands two classes of objective reals will be called a *Dualistic* concept; whereas a concept which demands only one such class will be called a *Monistic* concept.

The classical concept is dualistic; Leibnizian concepts will be, in general, monistic (cf. however Concept IVA). Occam's razor—Entia non multiplicanda præter necessitatem—formulates an instinctive preference for a monistic as against a dualistic concept. Concept III below is an example of a Leibnizian monistic concept. The objective reals in it may be considered to represent either the particles or the points of the classical concept. But they change their spatial relations. Perhaps Leibniz was restrained from assimilating his ideas more closely to Concept III by a prejudice against anything, so analogous to a point of space, moving—a prejudice which arises from confusing the classical dualistic concept with the monistic concepts. It is of course essential that at least some members of the class of objective reals should have different relations to each other at different instants. Otherwise we are confronted with an unchanging world. Concept V is another Leibnizian monistic concept.

The Time-Relation.—In every concept a dyadic serial relation, having for its field the instants of time and these only, is necessary. The properties of this *Time-Relation* form the pure science of chronology. The time-relation is, in all concepts, a serial relation ordinally similar to the serial relation which generates the series of negative and positive real numbers.* This fact need not be further specified during the successive consideration of the various concepts, nor need any of the propositions of pure chronology be enunciated.

Definition.—The class of instants of time is always denoted by T in every concept.

The Essential Relation.—In every concept at least all the propositions of geometry will be exhibited as properties of a single polyadic relation, here called the *essential relation.* The field of the essential relation will consist, *either* of the whole class of ultimate existents (e.g., in Concepts III, IVB and V), *or* of part of the class of objective reals together with the instants of time (e.g., in Concept IVA), *or* of the whole class of objective reals (e.g., in Concept II), *or* of part of the class of objective

* For interesting reflections on this subject, influenced by the Kantian Philosophy and previous to the modern 'Logicization of Mathematics,' cf. Hamilton, *Lectures on Quaternions*, preface.

reals (e.g., in Concept I). The essential relation of any one concept will be a relation between a definite finite number of terms, for example, between three terms in Concepts I and II, between four terms in Concept III, and between five terms in Concepts IV and V.*

Definition.—In the exposition of every concept, the essential relation of that concept is denoted by R.

The Extraneous Relations.—In all the concepts here considered, other relations, here called the *extraneous relations*, will be required in addition to the time-relation and the essential relation. In Concepts I and II and IV an indefinite (if not infinite) number of extraneous relations are required, determining the positions of particles. In Concepts III, IV and V one tetradic extraneous relation is required to determine the 'kinetic axes' of reference for the measurement of velocity.

The time-relation, the essential relation and the extraneous relations form the fundamental relations of any concept in which they occur.

It will now be necessary to define geometry anew, since the previous definition has essential reference to the dualism of the classical concept. A proposition of geometry is any proposition (1) concerning the essential relation; (2) involving one, and only one, instant of time; (3) true for any instant of time.

In the classical concept everything is sacrificed to simplicity in reference to geometry, probably because it arose when geometry was the only developed science. The result is that, when the properties of matter are dealt with, an appalling number of extraneous relations are necessary.

Judged by Occam's principle, this class of extraneous relations forms a defect in Concepts I and II and IV. Also, in both forms of the classical concept (viz., in Concepts I and II) geometry is segregated from the other physical sciences to a greater degree than in the other concepts.

* The idea of deriving geometry (at least projective geometry without reference to order) from a single triadic relation was (I believe) first enunciated and investigated by Mr. A. B. Kempe, F.R.S., in 1890, cf. 'On the Relation between the Logical Theory of Classes and the Geometrical Theory of Points,' *Proc. Lond. Math. Soc.*, Vol. XXI. It has since been worked out in detail for Euclidean geometry by Dr. O. Veblen, cf. 'A System of Axioms for Geometry,' *Trans. Amer. Math. Soc.*, Vol. 5, 1904. Also cf. Professor J. Royce on 'The Relation of the Principles of Logic to the Foundations of Geometry,' *Trans. Amer. Math. Soc.*, 1905. Professor Royce emphasises the importance of Kempe's work and considerably extends it. This memoir (which unfortunately only came into my hands after the completion of the present investigation) anticipates a general line of thought of the present paper in the emphasis laid on the derivation of geometry from a single polyadic relation; otherwise our papers are concerned with different problems.

In the study of any concept there are four logical stages of progress. The first stage consists of the *definition* of those entities which are capable of definition in terms of the fundamental relations. These definitions are logically independent of any axioms concerning the fundamental relations, though their convenience and importance are chiefly dependent upon such axioms. The second stage consists of the *deduction* of those properties of the defined entities which do not depend upon the axioms. The third stage is the *selection* of the group of *axioms* which determines that concept of the material world. The fourth stage is the *deduction* of propositions which involve among their hypotheses some or all of the axioms of the third stage. Psychologically the order of study is apt to be inverted, by first choosing propositions of the second and fourth stages because of their parallelism with the propositions of sense-perception and then by considering the first and third stages. The essential part of our task in passing concepts in review is the exhibition of the first and third stages. The second and fourth stages will only be so far touched upon as seems desirable for the purposes of elucidation.

Thus in respect to each concept considered the investigation will proceed as follows:—A certain relation R (the essential relation of the concept in question), which holds between a certain definite number of entities, is considered. The class of entities, between sets of which this relation holds, is called the 'field' of R. Definitions of entities allied to R and to entities of the field of R are then given. These definitions involve no hypotheses as to the properties of R, but are of no importance unless R has as a matter of fact certain properties. For example, it may happen that the classes, thus defined, are all the null class (i.e., the class with no members) unless R has the requisite properties. Again deductions (in the second stage), made without any hypothesis as to the properties of R, may be entirely trivial unless R has certain properties. If R has not the requisite properties the deductions often sink into the assertion that a certain proposition which is false implies some other proposition. This is true* but trifling. The 'axioms' respecting R are then given. These are the hypotheses as to the properties of R which are required in the concept under consideration. Finally such deductions are given as are necessary to elucidate the concept.

None of the reasoning of this memoir depends on any special logical doctrine which may appear to be assumed in the form in which it is set

* Cf. Russell, *The Principles of Mathematics*, § 16.

out. Furthermore certain contradictions recently discovered have thrown grave doubt upon the current doctrine of classes as entities. Any recasting of our logical ideas upon the subject of classes must of course simply issue in a change of our ideas as to the true logical analysis of propositions in which classes appear. The propositions themselves, except a few extreme instances which lead to contradictions, must be left intact. Accordingly the present memoir in no way depends upon any theory of classes.

The above considerations as to method must essentially hold for any investigation respecting axioms of geometry or of physics, viewed purely as deductive sciences, and apart from the question of experimental verification.

In Concepts I, II, and III the members of the 'field' of R are to be considered as points, except those members of the field which are instants of time. In these concepts the lines and planes are classes of points. In Concepts IV and V the members of the 'field' of R, other than the instants of time, are to be considered as lines taken as simple entities. Points are classes of these simple lines. But the ordinary line of geometry which has parts and segments is a class of points, and so is the ordinary plane of geometry. In Concept III, which is Leibnizian and monistic, the points (perhaps 'particles' is here a better word) move, and the straight lines and planes disintegrate from instant to instant. In Concepts IV and V the points similarly disintegrate.

(ii) Explanation of Symbolism

This explanation is only concerned with the general logical symbolism. The special symbols which arise out of the ideas of the paper are defined in their proper places. Peano's* chief symbols are used. The changes and developments from Peano, which will be found here, are due to Russell and myself working in collaboration for another purpose. It would be impossible to disentangle our various contributions.†

None of the reasoning of the paper is based upon any peculiarity of the symbolism. It is used here only as an alternative form for enunciations, for the sake of its conciseness and (above all) its precision. In the verbal enunciations precision has been to some extent sacrificed to

* Cf. *Notations de Logique Mathématique*, Turin, 1894; and *Formulaire Mathématique* (Turin, 1903).

† See, however, Russell's articles, 'Sur la Logique des Relations,' *Revue de Mathématiques*, Vol. VII, 1900–1901 (Turin).

lucidity; and the exact statement of what is meant is always to be sought in the symbolic alternative form. The proofs have been translated into words out of the symbolic form in which they were mostly elaborated.

On $\supset$, $\equiv$, $\subset$, ϵ, $=$, $=$ Df

There are five copulas, namely, $\supset$, $\equiv$, $\subset$, ϵ, $=$. Here $x \supset y$ means *x implies y;* and $x \equiv y$ means *x implies y and y implies x;* and $x \subset y$ means *all x's are y's;* and $x \epsilon y$ means *x is a member of y;* and $x, y \epsilon u$ means *x and y are members of u.* Note that $x \subset y$ implies that x is a subclass of y; a class will be said to *contain* a subclass and to *possess* a member. Lastly, $x = y$ means *x is identical with y.* Note that, if Df, short for Definition, is placed at the end of the line, thus,

$$x = y \qquad \text{Df}$$

the symbols mean that *x is defined to stand for y.* In such a case y is some complex of symbols, and x will be an abbreviated symbol standing for y.

On $\phi!x$, $(x) \,.\, \phi!x$, $(\exists x) \,.\, \phi!x$, (x, y), $(\exists x, y)$, $\supset_x$

Propositional Functions.—$\phi!x$ means *x has the property* ϕ, where ϕ is given different forms corresponding to different properties; $\exists!x$ means *x has the property of being a class possessing at least one member;* and $(x) \,.\, \phi!x$ means $\phi!x$ *is true for every value of x;* and $(\exists x) \,.\, \phi!x$ means *there exists a value of x for which* $\phi!x$ *is true.* Note that (x) and $(\exists x)$, written before any proposition involving x, give the above meanings, even if the proposition is not in the symbolic form $\phi!x$. If the proposition involve both x and y, then (x, y) prefixed means that the proposition is true for all values of x and y; and similarly for (x, y, z), and so on. Also $(\exists x, y)$ prefixed means that there exist values of x and y, such that the proposition is true; and similarly for $(\exists x, y, z)$, and so on. Furthermore $\phi \,!\, x \supset_x \psi!x$ stands for $(x) \,.\, \{\phi!x \supset \psi!x\}$, and similarly for two and three variables.

On the Use of Dots, viz., ., :, ∴, : :

$p \,.\, q$ or $p : q$ or $p \therefore q$ or $p : : q$ all mean *p and q are both true propositions.* As an example, $x, y \epsilon u$, which has been defined above, is really the proposition $x \epsilon u \,.\, y \epsilon u$; and $x, y, z \epsilon u$ is the proposition $x \epsilon u \,.\, y \epsilon u \,.\, z \epsilon u$.

Dots as Brackets.—The different symbolic forms for the joint assertion of propositions arise from the fact that dots are also used as bracket forms for propositions according to the following rules:—

(i) The larger aggregation of dots represents the exterior bracket. (ii) The dots at the end of a complete sequence of symbols are omitted. (iii) The dots immediately preceding or succeeding the implication sign, viz., $\supset$, are exterior brackets to any equal number of dots occurring in other capacities (e.g., as above in the joint assertion of propositions). (iv) The dots which also serve to indicate the joint assertion of propositions are interior brackets to any equal number of dots occurring in other capacities. (v) The dots after (x) and $(\exists x)$ are increased in number according to the necessity for their use as brackets.

In reading a symbolic proposition it is best to begin by searching for that implication sign, viz., $\supset$, which is preceded or succeeded by the greatest number of dots. This splits up the proposition into hypothesis and consequent; and so on with these subsidiary propositions, if necessary.

On $\vee$, $\backsim$, $\backsim\epsilon$, $\neq$, $\backsim(x) \,.\, \phi!x$, $\backsim(\exists x) \,.\, \phi!x$

Again $p \vee q$ means *one or other or each of p and q is a true proposition;* and $\backsim p$ means *p is not true.* Thus $\backsim\phi!x$ means *x has not the property* ϕ; also $x \backsim \epsilon u$ stands for $\backsim(x \epsilon u)$; and $x \neq y$ stands for $\backsim(x = y)$; and $\backsim(x) \,.\, \phi!x$ stands for $\backsim\{(x) \,.\, \phi!x\}$; and $\backsim(\exists x) \,.\, \phi!x$ stands for $\backsim\{(\exists x) \,.\, \phi!x\}$.

On $\dot{x}(\phi!x)$, $(\imath x)\,(\phi!x)$, ι‘, $\imath$‘, $\cup$, $\cap$, $\cup$‘, $\cap$‘

Non-Propositional Functions.—$\dot{x}(\phi!x)$ denotes *the class of terms which have the property* ϕ, and $(\imath x)\,(\phi!x)$ denotes *the single entity* (*if there is such*) *which, when substituted for x, makes* $\phi!x$ *to be a true proposition.* It is not necessary for the above symbolism that the proposition involving x should be in the symbolic form $\phi!x$. Again, ι‘x denotes *the class possessing x as its sole member*, and $\imath$‘x denotes *the sole member of the class x*, and $u \cup v$ denotes *the logical sum of u and v*, that is, the class possessing all members of u and all members of v and no other members. Thus, ι‘$a \cup \iota$‘b denotes the class whose sole members are a and b. Again, $u \cap v$ denotes *the logical product of u and v*, that is, the complete common subclass of u and v; and $\cup$‘u denotes *the class which is the logical sum of all members of u*, that is, the class which has as members all members of members of u; and $\cap$‘u denotes *the class*

which is the logical product of all members of u. The exact symbolic definition of $\cap$'u is

$$\cap\text{'}u = \dot{x}\{v \epsilon u \,.\, \supset_{v} \,.\, x \epsilon v\} \qquad \text{Df}$$

It follows from this definition that, if u possess no members, $\cap$'u is the class of all entities.

On Λ, cls', $-$, Nc'

Again, Λ denotes the *null class*, that is, the class with no members; cls'u denotes *the class whose members are the subclasses contained in u, including u itself and the null class.* It follows that the propositions, $v \epsilon \text{cls}'u$ and $v \subset u$, have practically identical meanings. Again, $u - v$ denotes *the class u with the exception of those members which it possesses in common with v.*

The cardinal numbers* are themselves classes. Thus, 1 is the class whose members are the unit classes, 2 is the class whose members are couples. Accordingly, $x \epsilon 2$ means *x is a class with two members;* Nc'u denotes *the cardinal number of the class u.*

On ϕ', ϕ'', ι'', $\imath$'', $\cup$'', *and so on.*

The general form for a non-propositional function whose value depends on x is ϕ'x, where ϕ receives different forms for different functions, as has been illustrated by the particular cases considered above. The apostrophe may be read as 'of'; it is the general symbol for the connection of the preceding functional sign with the succeeding argument. According to this rule we should write sin'x for sin x and log'x for log x. Again, ϕ''u denotes *the class of values of* ϕ'x, *when the various members of u are substituted for x;* it may be read 'the class of ϕ's of u's.' Thus, if ϕ'x is 'the head of x,' and u is 'the class of horses,' then ϕ''u is 'the class of heads of horses.' The exact symbolic definition of ϕ''u is as follows:

$$\phi''u = \dot{z}\{(\exists x) \,.\, x \epsilon u \,.\, z = \phi'x\} \qquad \text{Df}$$

It follows from the definition, by substituting for ϕ, that $\iota''u$, $\imath''u$, $\cup''u$, $\cap''u$, cls''u, Nc''u are now defined.

* Cf. Russell, *Principles of Mathematics*, Chap. XI, and Frege, *Grundlagen der Arithmetik*, (Breslau, 1884), pp. 79, 85.

On $(\mathrm{E}x)(\phi`y)$

Again, $(\mathrm{E}x)(\phi`y)$ means *there exists an entity which is denoted by the non-propositional function* $\phi`z$, *when* z *has the particular value* y. For example, if u is a class, there is such an entity as its cardinal number, denoted by $\mathrm{Nc}`u$; but if u is not a class, there is no such entity as its cardinal number.*

On Symbols of the Type $\mathrm{R}:(\ \ )$.

Relations.—$\mathrm{R}:(xyz)$ means x, y, z *form an instance in which the triadic relation* R *holds, the special 'positions' of* x, y, z *in this instance of that relationship being indicated by their order of occurrence in the symbol* $\mathrm{R}:(xyz)$. Again, $\mathrm{R}:(\cdot\, yz)$ means *there exists an entity,* x *say, such that* $\mathrm{R}:(xyz)$. The symbolic definitions of $\mathrm{R}:(\cdot\, yz)$, and of analogous symbols, are

$$\mathrm{R}:(\cdot\, yz) \,.=.\, (\exists x) \,.\, \mathrm{R}:(xyz) \qquad \mathrm{Df}$$
$$\mathrm{R}:(x\cdot z) \,.=.\, (\exists y) \,.\, \mathrm{R}:(xyz) \qquad \mathrm{Df}$$
$$\mathrm{R}:(xy\cdot) \,.=.\, (\exists z) \,.\, \mathrm{R}:(xyz) \qquad \mathrm{Df}$$
$$\mathrm{R}:(x\cdot\cdot) \,.=.\, (\exists y, z) \,.\, \mathrm{R}:(xyz) \qquad \mathrm{Df}$$
$$\mathrm{R}:(\cdot\, y\cdot) \,.=.\, (\exists x, z) \,.\, \mathrm{R}:(xyz) \qquad \mathrm{Df}$$

and so on. Again, $\mathrm{R}:(;yz)$ denotes *the class of terms, such as* x *(say), which satisfy* $\mathrm{R}:(xyz)$, and $\mathrm{R}:(\cdot;z)$ denotes *the class of terms, such as* y *(say), such that there exists a term,* x *say, such that* $\mathrm{R}:(xyz)$ *holds.* The symbolic definitions of $\mathrm{R}:(;yz)$ and of analogous entities, and of $\mathrm{R}:(\cdot;z)$ and of analogous entities, are

$$\mathrm{R}:(;yz) = \dot{x}\{\mathrm{R}:(xyz)\} \qquad \mathrm{Df}$$
$$\mathrm{R}:(x;z) = \dot{y}\{\mathrm{R}:(xyz)\} \qquad \mathrm{Df}$$
$$\mathrm{R}:(xy;) = \dot{z}\{\mathrm{R}:(xyz)\} \qquad \mathrm{Df}$$
$$\mathrm{R}:(;\cdot z) = \dot{x}\{(\exists y) \,.\, \mathrm{R}:(xyz)\} \qquad \mathrm{Df}$$
$$\mathrm{R}:(\cdot;z) = \dot{y}\{(\exists x) \,.\, \mathrm{R}:(xyz)\} \qquad \mathrm{Df}$$
$$\mathrm{R}:(;y\cdot) = \dot{x}\{(\exists z) \,.\, \mathrm{R}:(xyz)\} \qquad \mathrm{Df}$$

* The difficult question of the import of a proposition, which contains a non-propositional function (with some particular entity as argument) to which no entity corresponds, has recently been elucidated by Russell, cf. *Mind*, October, 1905. All propositions containing such a function are untrue, unless the function is merely a constituent of a subsidiary proposition whose truth is not implied by the proposition in question.

and so on:

$$\mathrm{R}^{i}(;\cdot\cdot) = \dot{x}\{(\exists y, z) \,.\, \mathrm{R}^{i}(xyz)\} \qquad \text{Df}$$

$$\mathrm{R}^{i}(\cdot;\cdot) = \dot{y}\{(\exists x, z) \,.\, \mathrm{R}^{i}(xyz)\} \qquad \text{Df}$$

$$\mathrm{R}^{i}(\cdot\cdot;) = \dot{z}\{(\exists x, y) \,.\, \mathrm{R}^{i}(xyz)\} \qquad \text{Df}$$

Thus, $\mathrm{R}^{i}(;\cdot\cdot)$ denotes *the class of terms, such as x (say), such that there exist terms, y and z say, such that* $\mathrm{R}^{i}(xyz)$ *holds.*

Again, $\mathrm{R}^{i}(;;z)$ denotes *the class which is the logical sum of* $\mathrm{R}^{i}(;\cdot z)$ *and* $\mathrm{R}^{i}(\cdot;z)$; and $\mathrm{R}^{i}(;;\cdot)$ denotes *the class which is the logical sum of* $\mathrm{R}^{i}(;\cdot\cdot)$ *and* $\mathrm{R}^{i}(\cdot;\cdot)$; and $\mathrm{R}^{i}(;;;)$ denotes *the class which is the logical sum of* $\mathrm{R}^{i}(;\cdot\cdot)$ *and* $\mathrm{R}^{i}(\cdot;\cdot)$ *and* $\mathrm{R}^{i}(\cdot\cdot;)$, that is, the 'field' of the relation R. The symbolic definitions of the above, and of similar entities, are:

$$\mathrm{R}^{i}(;;z) = \mathrm{R}^{i}(;\cdot z) \cup \mathrm{R}^{i}(\cdot;z) \qquad \text{Df}$$

$$\mathrm{R}^{i}(;y;) = \mathrm{R}^{i}(;y\cdot) \cup \mathrm{R}^{i}(\cdot y;) \qquad \text{Df}$$

$$\mathrm{R}^{i}(x;;) = \mathrm{R}^{i}(x;\cdot) \cup \mathrm{R}^{i}(x\cdot;) \qquad \text{Df}$$

$$\mathrm{R}^{i}(;;\cdot) = \mathrm{R}^{i}(;\cdot\cdot) \cup \mathrm{R}^{i}(\cdot;\cdot) \qquad \text{Df}$$

and so on, and

$$\mathrm{R}^{i}(;;;) = \mathrm{R}^{i}(;\cdot\cdot) \cup \mathrm{R}^{i}(\cdot;\cdot) \cup \mathrm{R}^{i}(\cdot\cdot;) \qquad \text{Df}$$

This notation, which has been explained for triadic relations, can obviously be extended to any polyadic relations. Thus, $\mathrm{R}^{i}(abcd)$ and $\mathrm{R}^{i}(abcdt)$ are defined in a similar manner, and so are the symbols for the allied propositions and classes.

On $1 \longrightarrow 1$.

A dyadic relation, S say, is called *one-one*, when each referent has only one relatum, and each relatum has only one referent. The class of one-one relations is denoted by $1 \longrightarrow 1$. The symbolic definition is

$$1 \longrightarrow 1 \;.=.\; \dot{S}\{S \in \text{relation} : x \in \mathrm{S}^{i}(;\cdot) \,.\, \supset_{x} \,.\, \mathrm{S}^{i}(x;) \in 1 : y \in \mathrm{S}^{i}(\cdot;) \,.\, \supset_{y} \,.\, \mathrm{S}^{i}(;y) \in 1\} \qquad \text{Df}$$

On $\vdash$

The Assertion Sign.—A proposition, which is stated in symbols as being true, i.e., which is *asserted* as distinct from being *considered*, has the symbol $\vdash$ prefixed to it, with as many dots following as will serve to bracket off the proposition. This symbol $\vdash$ is called the *assertion sign.**

* This symbol is due to Frege, who first drew attention to the necessity of the idea which it symbolizes; cf. his 'Begriffschrift,' Halle (1879), and Russell, *Principles of Mathematics*, p. 35.

PART II *THE PUNCTUAL CONCEPTS*

Those concepts of the material world in which the class of objective reals is composed of *points*, or *particles*, or of *both*, will be called the *punctual* concepts. The classical concept is a punctual concept, and will be considered first. The other punctual concepts can be explained briefly by reference to the classical concept.

Concept I.—(*The Classical Concept*).—This is dualistic, the class of objective reals being subdivided into *points of space* and *particles of matter*. The essential relation has for its field the points of space only. Slight variants (not considered here) can be given to the concept by varying the properties of the essential relation, so as to make the geometry non-Euclidean, or, retaining Euclidean geometry, so as to give various forms to the essential relation and the resulting axioms. In the exposition of a system of geometrical axioms for Concept I, Veblen's memoir (cf. *loc. cit.*), to which I am largely indebted, will be followed. The changes which are made from Veblen's treatment are (i) in the addition of the symbolism which emphasizes the idea of the essential relation, and (ii) in the fact that the question of the independence of axioms is here ignored, through a desire not to overload this memoir with difficulties (both for the author and reader) belonging to another part of the subject. As the result of (ii), some of Veblen's definitions and axioms have been simplified (and, in a sense, spoiled). The axioms thus obtained for Concept I will shorten our investigations of other concepts by serving as a standard of comparison to determine whether the axioms of the other concepts are sufficient to yield three-dimensional Euclidean geometry.*

* On the philosophical questions connected with the mathematical analysis of geometry cf. *A Critical Exposition of the Philosophy of Leibniz* (Cambridge, 1900) and *The Principles of Mathematics* (Cambridge, 1903), both by Bertrand Russell; and also two articles by L. Couturat in the *Revue de Métaphysique et de Morale* (Paris) for May and September, 1904, one entitled 'La philosophie des Mathématiques de Kant' and the other 'Les principes des Mathématiques—VI. La géometrie'; also Poincaré's *Science and Hypothesis*, Part II (Engl. transl., London, 1905).

For expositions of exact systems of axioms cf. *Vorlesungen über neuere Geometrie* (Leipzig, 1882), by Pasch; also *I Principii di Geometria* (Turin, 1889), by Peano; also 'I Principii della Geometria di Posizione,' *Transl. Acad. of Turin*, (1898), by Pieri;

The essential relation (called R) is triadic. $R^{\iota}(abc)$ means *the points a, b, c are in the linear order* (*or the* R-*order*) *abc*. The relation R, when $R^{\iota}(abc)$ holds, is not symmetrical as between the three points *a*, *b*, and *c;* namely, it will be found that *a* and *b* (or *b* and *c*) cannot be interchanged.

Definitions of Concept I

Definition.—The class $R^{\iota}(a;b)$ is the *segment between a and b;* and the class $R^{\iota}(ab;)$ is the *segmental prolongation of ab beyond b;* and the class $R^{\iota}(;ab)$ is the *segmental prolongation of ab beyond a.* It follows from the subsequent axioms that $R^{\iota}(ab;)$ is identical with $R^{\iota}(;ba)$.

Definition.—The *straight line ab* is the logical sum of $R^{\iota}(a;b)$ and $R^{\iota}(;ab)$ and $R^{\iota}(ab;)$ together with *a* and *b* themselves. Its symbol is $R^{\iota}\overline{ab}$. The definition in symbols is

$$R^{\iota}\overline{ab} = R^{\iota}(;ab) \cup R^{\iota}(a;b) \cup R^{\iota}(ab;) \cup \iota'a \cup \iota'b \qquad \text{Df}$$

Definition.—The class whose members are the various straight lines is denoted by lin_R. The definition in symbols is

$$\text{lin}_R = \nu\{(\exists a, b) \,.\, a, b \in R^{\iota}(;;;) \,.\, a \neq b \,.\, \nu = R^{\iota}\overline{ab}\} \qquad \text{Df}$$

Definition.—Any class of points [i.e., members of $R^{\iota}(;;;)$] is called a *figure.*

Definition.—The *class of lines defined by a figure u* is the class of lines defined by any two distinct points of *u*. Its symbol is $\text{ln}_R{}'u$. The definition in symbols is

$$\text{ln}_R{}'u = \dot{\nu}\{(\exists x, y) \,.\, x, y \in u \cap R^{\iota}(;;;) \,.\, x \neq y \,.\, \nu = R^{\iota}\overline{xy}\} \qquad \text{Df}$$

Definition.—The *linear figure defined by a figure u* is the logical sum of all the lines defined by *u* (i.e., is all the points on such lines). Thus its symbol is $\cup'\text{ln}_R{}'u$.

Definition.—Three points form a triangle, if there is no line which possesses them all. The symbol expressing that *a*, *b*, *c* are points forming a triangle is $\triangle_R{}^{\iota}(abc)$. The definition in symbols is

$$\triangle_R{}^{\iota}(abc) \,.=\, .\, a, b, c \in R^{\iota}(;;;) \,.\, \backsim(\exists \nu) \,.\, \nu \in \text{lin}_R \,.\, a, b, c \in \nu \qquad \text{Df}$$

---

also Hilbert's *Foundations of Geometry* (Engl. Transl., Chicago, 1902); also Professor E. H. Moore, 'On the Projective Axioms of Geometry,' *Transact. of the Amer. Math. Soc.* (1903); also Dr. O. Veblen (*loc. cit.*); also Professor J. Royce (*loc. cit.*).

Definition.—The *space defined by the triangle abc* is the linear figure defined by the linear figure defined by the three points *a*, *b*, *c*. Its symbol is $\Pi_R(abc)$. The definition in symbols is

$$\Pi_R(abc) = \cup\text{`}\ln_R\text{`}\cup\text{`}\ln_R\text{`}(\iota\text{`}a\cup\iota\text{`}b\cup\iota\text{`}c) \qquad \text{Df}$$

Definition.—The *class of planes* is the class of spaces defined by any three points *a*, *b*, *c* when they form a triangle. Its symbol is ple_R. The definition in symbols is

$$\text{ple}_R = \dot{\nu}\{(\exists a, b, c) \,.\, \triangle_R\text{`}(abc) \,.\, \nu = \Pi_R(abc)\} \qquad \text{Df}$$

Definition.—The space defined by the four points *a*, *b*, *c*, *d* is the linear figure defined by the figure which is the logical sum of $\Pi_R(bcd)$ and $\Pi_R(acd)$ and $\Pi_R(abd)$ and $\Pi_R(abc)$. Its symbol is $\Pi_R(abcd)$. The symbolic definition is

$$\Pi_R(abcd) = \cup\text{`}\ln_R\text{`}\{\Pi_R(bcd)\cup\Pi_R(acd)\cup\Pi_R(abd)\cup\Pi_R(abc)\} \quad \text{Df}$$

The above definitions are sufficient to exhibit the dependence of the various geometrical entities on the essential relation, and also to enable us, as far as geometry is concerned, to pass on to the third stage. Owing to the simplicity of the definitions, the second stage for this concept is of very small importance.

It will be noticed that none of the definitions contain any reference to length, distance, area, or volume. This is because none of these ideas appear in the axioms, and only such definitions are given here as are necessary for the enunciation of the axioms. According to the well-known* method of projective metrics, the ideas are introduced by definition and require no special axiom.

Axioms of Concept I

The axioms, it must be remembered, are merely an enumeration of various propositions concerning the properties of the fundamental relations, which will occur as hypotheses in the propositions of the fourth stage. In this instance we are merely considering the axioms of geometry, and these concern the essential relation (R) only. The axioms will be named systematically thus, I H*p* R, II H*p* R, III H*p* R, and

* Cf. Veblen, *loc. cit.*; also *Vorlesungen über Geometrie*, by Clebsch, third part; also *The Principles of Mathematics*, by Russell, Chap. XLVIII.

so on. Their enumeration will take the form of defining these *names* as abbreviations standing for the various statements, which will be used subsequently as hypotheses.

I H*p* R is the statement that there is at least one set of entities, *a*, *b*, *c*, such that R^{i}(*abc*) is true. The definition in symbols is

$$\text{I H}p\ \text{R} \ .=. \ \exists!\text{R}^{i}(;;;) \qquad \text{Df}$$

II H*p* R is the statement that R^{i}(*abc*) implies R^{i}(*cba*). The definition in symbols is

$$\text{II H}p\ \text{R} \ .=: (a, b, c) : \text{R}^{i}(abc) \ .\supset. \ \text{R}^{i}(cba) \qquad \text{Df}$$

III H*p* R is the statement that R^{i}(*abc*) is inconsistent with R^{i}(*bca*). The definition in symbols is

$$\text{III H}p\ \text{R} \ .=: (a, b, c) : \text{R}^{i}(abc) \ .\supset. \ \backsim \text{R}^{i}(bca) \qquad \text{Df}$$

IV H*p* R is the statement that R^{i}(*abc*) implies that *a* is distinct from *c*. The definition in symbols is

$$\text{IV H}p\ \text{R} \ .=: (a, b, c) : \text{R}^{i}(abc) \ .\supset. \ a \neq c \qquad \text{Df}$$

V H*p* R is the statement that, if *a* and *b* are distinct points, the segmental prolongation of *ab* beyond *b* possesses at least one member. The definition in symbols is

$$\text{V H}p\ \text{R} \ .=: (a, b) : a, b \in \text{R}^{i}(;;;) \ . \ a \neq b \ .\supset. \ \exists!\{\text{R}^{i}(ab;)\} \qquad \text{Df}$$

VI H*p* R is the statement that, if *c* and *d* are distinct points, possessed by the line defined by the points *a* and *b*, then *a* is possessed by the line defined by *c* and *d*. The definition in symbols is

$$\text{VI H}p\ \text{R} \ .=: (a, b, c, d) : c, d \in \text{R}^{i}\overline{ab} \ . \ c \neq d \ .\supset. \ a \in \text{R}^{i}\overline{cd} \qquad \text{Df}$$

VII H*p* R is the statement that there exist at least three points forming a triangle. The definition in symbols is

$$\text{VII H}p\ \text{R} \ .=. \ (\exists\, a, b, c) \ . \ \triangle_{\text{R}}{}^{i}(abc) \qquad \text{Df}$$

VIII H*p* R is the statement that, if *a*, *b*, *c* be three points forming a triangle, and R^{i}(*bcd*) and R^{i}(*cea*) hold, then there exists a point possessed both by the segment *ab*, and by the line defined by *d* and *e*. The definition in symbols is

VIII Hp R . = : $(a, b, c, d, e) : \triangle_R{}^{\iota}(abc) . R^{\iota}(bcd) . R^{\iota}(cea)$
$. \supset . \exists ! \{R^{\iota}\breve{d}e \cap R^{\iota}(a;b)\}$ Df

IX Hp R is the statement that there exist a point and a plane, such that the plane does not possess the point. The definition in symbols is

IX Hp R . = : $(\exists p, d) . p \in \text{ple}_R . d \in R^{\iota}(;;;) - p$ Df

X Hp R is the statement that there exist four points a, b, c, d, such that the three-dimensional space $\Pi_R(abcd)$ contains the whole class of points. The definition in symbols is

X Hp R . = . $(\exists\, a, b, c, d) . R^{\iota}(;;;) \subset \Pi_R(abcd)$ Df

XI Hp R is some statement which secures the continuity (in Cantor's sense) of the points on a line. The axiom need not be given here, since there will be no reasoning in this memoir connected with it.

XII Hp R is the statement that, if α be any plane and a a line contained in it, then there exists a point c in α, such that there is not more than one line, possessing c and contained in the plane α and not intersecting a. The definition in symbols is

XII Hp R . = $\therefore \alpha \in \text{ple}_R . a \in \text{lin}_R \cap \text{cls}`\alpha . \supset_{a,\alpha} : (\exists c) : c \in \alpha :$
$l, l' \in \text{lin}_R \cap \text{cls}`\alpha . c \in l \cap l' . l \cap a = \Lambda . l' \cap a = \Lambda . \supset_{l,l'} . l = l'$ Df

Of these axioms, IX Hp R secures that space is of three dimensions at least, and X Hp R secures that it is of three dimensions at most, and XII Hp R is the 'Euclidean' axiom. From these twelve axioms the whole of geometry* can be deduced. The well-known parabolic (i.e., Euclidean) *definition* of distance (not given here) assumes an important significance, and all the usual metrical properties follow.

The Extraneous Relations.—Nothing could be more beautiful than the above issue of the classical concept, if only we limit ourselves to the consideration of an unchanging world of space. Unfortunately, it is a changing world to which the complete concept must apply, and the intrusion at this stage into the classical concept of the necessity of providing for change can only spoil a harmonious and complete whole. Owing to the fact that the instants of time are not members of the field of the essential relation, the time relation and the essential relation have (so to speak) no point of contact. To remedy this, another subdivision of the class of objective reals is conceived, namely, the class of *particles*

* Cf. Veblen, *loc. cit.*

(where the particles are the ultimate entities composing the fundamental 'stuff' which moves in space). These particles must form part of the fields of a class of extraneous relations. Each such extraneous relation is conceived as a triadic relation, which in any particular instance holds between a particle, a point of space, and an instant of time. Also the field of each such extraneous relation only possesses one particle, and no particle belongs to the field of two such relations. Thus each extraneous relation is peculiar to one particle. Also, as has been pointed out by Russell,* to whom the above analysis of these extraneous relations of the classical concept is in substance due, the impenetrability of matter is secured by the axiom that two different extraneous relations cannot both relate the same instant of time to the same point. The general laws of dynamics, and all the special physical laws, are axioms concerning the properties of this class of extraneous relations.

Thus the classical concept is not only dualistic, but has to admit a class of as many extraneous relations as there are members of the class of particles.

Instead of the specific relations of occupation for the various particles, one general triadic relation of occupation can be considered. Thus, $O^{:}(pAt)$ may be considered as the statement the particle p occupies the point A at the instant t. Then for any given A and t there is either one only or no particle p for which $O^{:}(pAt)$ is true. Then the laws of physics are the properties of this single extraneous relation O. But the use of this single relation apparently introduces no real simplification, differing in this respect from the use of the essential relation which so simplifies the statement of the axioms of geometry. The general relation O remains a mere alternative statement of the facts respecting the various specific relations of occupation.

Concept II.—This concept is a monistic variant of the classical concept suggested by Russell.† In the classical concept the particles only occur as terms in the triadic extraneous relations. If we abolish the particles (in the 'classical' sense), and transform the extraneous relations into dyadic relations between points of space and instants of time, everything will proceed exactly as in the classical concept. The reason for the original introduction of 'matter' was, without doubt, to give the senses something to perceive. If a relation can be perceived, this Concept II has every advantage over the classical concept. Otherwise the

* Cf. *Principles of Mathematics*, Vol. I, § 440.
† *Ibid.*, § 441.

material world, as thus conceived, would appear to labour under the defect that it can never be perceived. But this is a philosophic question with which we have no concern.

Concept III.—This is a Leibnizian concept, and also a monistic variant of the classical concept, obtained by abandoning the prejudice against points moving.

This concept can be otherwise considered, as obtained from the modern (and Cartesian) point of view of the ether, as filling all space. The particles of ether (or moving points) compose the whole class of objective reals. The essential relation (R) is a tetradic relation, and, in each specific instance of the relation holding, three of the terms are objective reals and the remaining term is an instant of time. $R^i(abct)$ may be read as stating *the objective reals a, b, c are in the* R*-order abc at the instant t.* Instead of $R^i(abct)$, it will be convenient to write $R_t{}^i(abc)$. Then the geometrical definitions are exactly those of Concept I, replacing R everywhere by R_t. Also the geometrical axioms are those of Concept I; except (i) that R is replaced by R_t, (ii) that I Hp R, and VII Hp R, and IX Hp R, are further modified by the introduction of the hypothesis $t \in T$—thus I Hp R of Concept I becomes

$$\text{I H}p\ \text{R} \ .=: t \in \text{T} \ .\supset_t . \ \exists !R_t{}^i(;;:) \qquad \text{Df}$$

and similarly for the other two axioms, and (iii) that one additional axiom (the axiom of persistence) must be introduced, namely,

$$\text{XIII H}p\ \text{R} \ .=: t \in \text{T} \ .\supset_t . \ R^i(;;;\cdot) \subset R^i(;;;t) \qquad \text{Df}$$

This axiom of persistence is unnecessary for the geometrical reasoning, but is an integral part of the 'physical' side of the concept. Also the hypothesis $t \in T$, which is introduced in the three axioms (I, VII, IX) Hp R, is unnecessary in the other axioms, since it is implied by the hypotheses already existing. The same explanation holds of the absence of the hypothesis, $t \in T$, from many axioms and propositions of subsequent concepts.

Thus at each instant the objective reals may be considered as the points of the classical concept, and the whole of Euclidean geometry holds concerning them. But at another instant the points will not have preserved the same geometrical relations as held between them at the previous instant. Thus, in the comparison of the states of the objective reals at different instants, the objective reals assume the character of particles.

The Extraneous Relation.—A single extraneous relation is necessary to obviate the difficulty of comparing straight lines and planes at one instant with similar entities at another instant. In what sense can a point at one instant be said to have the *same position* as a point at another instant? This definition can be effected by introducing into the concept a single tetradic extraneous relation S, so that, when $S^i(uvwt)$ holds, t is an instant of time, and u, v, w are intersecting straight lines mutually at right angles. Also corresponding to any instant t in the fourth term, there is one and only one line for each of the other terms respectively. This last condition, expressed in symbols, is

$$t \in \mathrm{T} \,.\supset_t.\, S^i(;\cdot\cdot t) \in 1 \,.\, S^i(\cdot;\cdot t) \in 1 \,.\, S^i(\cdot\cdot;t) \in 1$$

The straight lines indicated at each instant by this relation are to be taken as the 'kinetic axes.'* Velocity and acceleration can now be defined, and a general continuity of motion (in some sense) must be included among the axioms.

This concept has the advantage over Concepts I and II that it has reduced the class of extraneous relations to one member only, in the place of the innumerable and perhaps infinite number of extraneous relations in the other two concepts. The concept pledges itself to explain the physical world by the aid of motion only. It was indeed a dictum with some eminent physicists of the nineteenth century that 'motion is of the essence of matter.' But this concept takes them rather sharply at their word. There is absolutely nothing to distinguish one part of the objective reals from another part except differences of motion. The 'corpuscle' will be a volume in which some peculiarity of the motion of the objective reals exists and persists. Two different developments, viz., Concept IIIA and Concept IIIB, are now possible, according as the persistence is taken to be of one or other of two possible types.

Concept IIIA.—Here the persistence is that of the *same objective reals* in the same special type of motion. Kelvin's vortex ring theory of matter can be adapted to such a concept.

Concept IIIB.—Here the persistence is that of the *type of motion* in some volume, but not necessarily of the identity of the objective reals in the volume. The *continuity of motion* of a corpuscle as a whole becomes then the *definition of the identity* of a corpuscle at one instant with a corpuscle at another instant.

* Cf. W. H. Macaulay, *Bulletin of the Amer. Math. Soc.* (1897).

PART III (i) *GENERAL EXPLANATIONS OF LINEAR CONCEPTS*

These concepts depart widely from the classical concept. The objective reals (at least those which, with the instants of time, form the field of the essential relation) have properties which we associate with straight lines, considered throughout their whole extent as single indivisible entities. These objective reals, which in Concept V are all the objective reals, will be called *linear objective reals*. Perhaps, however, a closer specification of the linear objective reals of these concepts is to say that they are the lines of force of the modern physicist, here taken to be ultimate unanalysable entities which compose the material universe, and that geometry is the study of a certain limited set of their properties. But this mode of realizing the nature of the linear objective reals has also its pitfalls, for a line of force suggests *ends*, while these linear objective reals have no properties analogous to the properties of the ends of lines of force. The whole of a straight line, viewed as a point-locus, will be found to be associated with a linear objective real. The 'linear' concepts here considered are all Leibnizian.

Concept IVA is dualistic, and requires among the objective reals a class of 'particles' in addition to the linear objective reals. Concept IVB is the monistic variant of Concept IVA, obtained exactly as Concept II is derived from Concept I. Both of the Concepts IVA and IVB labour under the same defect as Concepts I and II in requiring an indefinitely large class of extraneous relations. Concept V is monistic, and is by far the most interesting of the set of linear concepts. It requires only one extraneous relation to perform a similar office to that of the extraneous relation in Concept III.

Points are now defined complex entities, being certain classes of linear objective reals. Geometers are already used to the idea of the point as complex. In projective geometry, as derived from descriptive geometry, the projective point is nothing but a class of straight lines.* This idea will now be extended to all points; and the descriptive point,

* Cf. Pasch, *loc. cit.*, and Schur, 'Ueber die Einführung der sogennanten idealen Elemente in die projective Geometrie,' *Math. Annal.*, Vol. XXXIX, and Bonola, 'Sulla Introduzione degli Enti improprii in Geometria projettiva,' *Giorn. di Mat.*, Vol. XXXVIII.

from which in the current theory the projective point is ultimately derived, is here abolished. The 'Theory of Interpoints' [cf. Part III (ii)] and the 'Theory of Dimensions' [cf. Part IV (i)] represent two distinct methods of overcoming the following initial and obvious difficulty of these 'linear' concepts:—A point is to be defined as the class of objective reals 'concurrent' at a point. But this definition is circular. How can this circularity be removed? The Theory of Interpoints and the Theory of Dimensions give two separate answers to this question. The points in the linear concepts, being only classes of objective reals, are capable of disintegration. In fact, when motion is considered, it will be found that the points of one instant are, in general, different from the points of another instant, not in the sense of Concept III that they are the same entities with different relations, but in the sense that they are different entities. More difficulty will probably be felt in conceiving anything analogous to a line as a simple unity. Here it is to be observed that a linear objective real does not replace a line of points of ordinary geometry. On the contrary, the class of those points (here called a *punctual line*), which have a given linear objective real as a common member, is this ordinary geometrical line. A punctual line has parts and segments in the ordinary way. The idea of a single unity underlying a straight line is not wholly alien to ordinary language. The idea of a direction, as it could also be used in non-Euclidian geometries where each line will have its own peculiar direction, may be conceived as being that of a line taken as a unit. But it is unnecessary to elaborate these considerations, as they have no relation to the logic of the subject.

In the dualistic Concept IVA the particles form another class of objective reals in addition to the linear objective reals. Each particle is associated at each instant with some one point, that is, with some class of linear objective reals. Thus the two points, respectively associated at any instant with two particles, have in common one linear objective real. Thus, when mutually determined motions are considered, these linear objective reals assume the aspect of lines of force. In the monistic Concept V the analogy of objective reals to lines of force arises in a similar way. In this case particles, in the sense used above, do not exist. Corpuscles, to use another term, are defined entities, analogous to the corpuscles of Concept III; any general consideration of them is best deferred till the definitions can be understood.

In Concepts IV and V the conception of an ether is (in a sense) rendered unnecessary, or (in another sense) is largely modified. The

collection of linear objective reals (i.e., in Concepts IVB and V, of *all* objective reals) now forms the entity (the ether) which 'lies between' the corpuscles of gross matter. These corpuscles must be conceived as volumes with some peculiarity either of motion or of structure. Of course it might be found useful, for the explanation of physical phenomena, to assume that corpuscles of some sort are generally distributed between bodies of gross matter, thus forming an ether in a secondary sense. The ancient controversy concerning action at a distance becomes irrelevant in these concepts. In one sense there is something, not mere space, between two distant corpuscles, namely, the objective reals possessed in common; in another sense there is a direct action between two distant corpuscles not depending on intervening corpuscles. In fact, the premises common to both bands of disputants are swept away.

The Essential Relation.—In both of the Concepts IV and V the essential relation (R) is a pentadic relation, and has for its field both the class of instants of time and that of linear objective reals, that is, in Concept V the field is the complete class of ultimate existents. The proposition $R_i(abcdt)$ can be read as the statement that *the objective real a intersects the objective reals b, c, d in the order bcd at the instant t.* This conception of 'the intersection in order of three linear objective reals by a fourth at an instant of time' must be taken as a fundamental relation between the five entities. But the properties of the relation are not to be limited by the suggestion of the technical name 'intersection.' The axioms will be so assumed that $R_i(abcdt)$ implies that *a*, *b*, *c*, and *d* are distinct. Also, when points are defined, it will be found that the axioms secure that *a* intersects *b*, *c*, and *d* in distinct points. Furthermore, in general, *b*, *c*, and *d* are *not* co-punctual; so that the case when *a* is a transversal of the pencil *b*, *c*, *d* of *co-punctual* lines is only a particular case of the satisfaction of $R_i(abcdt)$.

Definitions.—The notation of the general symbolism provides us with the symbol $R_i(;;;;\cdot)$ for the class of linear objective reals, and with $R_i(\cdots\cdot;)$ for the class of instants. But these symbols are long. Accordingly O will be defined to stand for the class of linear objective reals, and T for the class of instants. Thus, in symbols,

$$O = R_i(;;;;\cdot) \qquad \text{Df}$$

$$T = R_i(\cdots\cdot;) \qquad \text{Df}$$

When 'particles' (in Concept IV) are not being directly considered, the term 'objective real' will be used instead of 'linear objective real,' or 'member of O.'

(ii) The Theory of Interpoints*

*1. The theory of *intersection-points* (shortened into *interpoints*) is required in both of the Concepts IV and V. Accordingly, it is convenient to investigate it before the special consideration of either concept. In Concept IV the interpoints are the points, and there are no other points. In Concept V the interpoints are, in general, only portions of points, and a point may contain no interpoint or many interpoints. Thus the axioms of Concept IV (cf. *2) and those of Concept V (cf. *22) are two alternative sets of hypotheses as to the properties of R in connection with which the theory of interpoints, as given in the present *1, assumes importance. Some axioms, involving interpoints in their statements, are identical in Concept IV and Concept V. These axioms are stated now in *1, and their simple consequences are deduced. The theory of interpoints depends on that of 'similarity of position' in a relation. This general idea will only be explained in the special form in which it is here required in respect to the essential relation R.

*1·11. *Definition.*—An entity, y, will be said to have a *position* in the pentadic relation R, *similar* to that of the entity x, with a as first term and t as last (fifth) term, if, whenever the relation holds between five terms, a being the first term and t the last term, and either x or y or both occurring among the other terms, the relation also holds when x is substituted for y (whenever y occurs), and also holds when y is substituted for x (whenever x occurs). The symbol $\mathrm{R}{:}\left(\frac{a???t}{x}\right)$ denotes the class of entities with positions similar to that of x in the relation R, a being first term and t last term. The definition in symbols is

* From this point a continuous argument commences, and the sections and included propositions are numbered by a combined integral and decimal system, the whole number for the section and the decimal part for the proposition, also the symbol (*) is placed before an integral number marking a section. All the easier proofs of propositions are omitted, those proofs remaining being retained either as specimens, or as containing some point of difficulty. The omitted proofs are often replaced by references to the preceding propositions used in them, as a guide to their reconstruction. Note that 'cf. *2·31·41·5' is used as a shortened form of 'cf. *2·31 and *2·41 and *2·5.'

$$\mathrm{R}_{\mathrm{i}}\left(\frac{a???t}{x}\right) . = : \dot{y}\{(\xi, \eta) : \mathrm{R}_{\mathrm{i}}(ax\xi\eta t) . \equiv . \mathrm{R}_{\mathrm{i}}(ay\xi\eta t) : \mathrm{R}_{\mathrm{i}}(a\xi x\eta t) . \equiv . \mathrm{R}_{\mathrm{i}}(a\xi y\eta t) : \mathrm{R}_{\mathrm{i}}(a\xi\eta xt) . \equiv . \mathrm{R}_{\mathrm{i}}(a\xi\eta yt)\} \quad \text{Df}$$

*1·12. *Proposition.*—If y is a member of $\mathrm{R}_{\mathrm{i}}\left(\frac{a???t}{x}\right)$, then $\mathrm{R}_{\mathrm{i}}\left(\frac{a???t}{y}\right)$ is identical with $\mathrm{R}_{\mathrm{i}}\left(\frac{a???t}{x}\right)$. In symbols,

$$\vdash : y \in \mathrm{R}_{\mathrm{i}}\left(\frac{a???t}{x}\right) . \supset . \mathrm{R}_{\mathrm{i}}\left(\frac{a???t}{y}\right) = \mathrm{R}_{\mathrm{i}}\left(\frac{a???t}{x}\right)$$

*1·13. *Proposition.*—x is a member of $\mathrm{R}_{\mathrm{i}}\left(\frac{a???t}{x}\right)$

*1·21. *Definition.*—A class P of objective reals is called an *intersection-point on a* (shortened into *interpoint on a*), when there exists an objective real x, which is member of $\mathrm{R}_{\mathrm{i}}(a;;;t)$, and P is the class whose members are a together with all the members of the class $\mathrm{R}_{\mathrm{i}}\left(\frac{a???t}{x}\right)$. The symbol $\mathrm{R}_{\mathrm{i}}(a???t)$ stands for *the class of interpoints on a at the instant t.* The definition in symbols is

$$\mathrm{R}_{\mathrm{i}}(a???t) = \dot{\mathrm{P}}\left\{(\exists x) . x \in \mathrm{R}_{\mathrm{i}}(a;;;t) . \mathrm{P} = \iota`a \cup \mathrm{R}_{\mathrm{i}}\left(\frac{a???t}{x}\right)\right\} \quad \text{Df}$$

*1·22. *Definition.*—P is called an *interpoint* of the relation R at the instant t, if there exists an objective real a, such that P is a member of $\mathrm{R}_{\mathrm{i}}(a???t)$. The symbol $\mathrm{intpnt}_{\mathrm{R}t}$ stands for *the class of interpoints of* R *at the instant t.* In symbols,

$$\mathrm{intpnt}_{\mathrm{R}t} = \dot{\mathrm{P}}\{(\exists a) . \mathrm{P} \in \mathrm{R}_{\mathrm{i}}(a???t)\} \quad \text{Df}$$

*1·23. *Proposition.*—If P and Q are distinct members of $\mathrm{R}_{\mathrm{i}}(a???t)$, then a is the sole member common to P and Q. In symbols,

$$\vdash : \mathrm{P}, \mathrm{Q} \in \mathrm{R}_{\mathrm{i}}(a???t) . \mathrm{P} \neq \mathrm{Q} . \supset . \iota`a = \mathrm{P} \cap \mathrm{Q}$$

Proof.—Cf. *1·11·12·21.

*1·31. *Definition.*—The interpoints B, C, D will be said to be in the *interpoint-order* BCD at the instant t with respect to the relation R, when there exist objective reals a, x, y, z, such that (1) B, C, D are members of $\mathrm{R}_{\mathrm{i}}(a???t)$; (2) x is a member of B, y of C, z of D; (3) $\mathrm{R}_{\mathrm{i}}(axyzt)$ holds. The symbol $\mathrm{R}_{\mathrm{in}}(\mathrm{BCD}t)$ stands for the statement that

the interpoints B, C, D *are in the interpoint-order* BCD *at the instant t with respect to the relation* R. In symbols,

$$R_{in}{}^{i}(BCDt) \;.=.\; (\exists a, x, y, z) \;.\; B, C, D \in R^{i}(a???t) \;.\; x \in B \;.\; y \in C \;.\; z \in D \;.\; R^{i}(axyzt) \qquad \text{Df}$$

*1·32. $\vdash$. $\text{intpnt}_{Rt} = R_{in}{}^{i}(;;;t)$

Proof.—The class $R_{in}{}^{i}(;;;t)$ is part (or all) of the class intpnt_{Rt} (cf. *1·31). Again (cf. *1·22), if B is a member of intpnt_{Rt}, objective reals a and x exist, such that x is a member of $R^{i}(a;;;t)$, and B is the interpoint possessing a and x. Hence there are objective reals y and z, such that *either* $R^{i}(axyzt)$ *or* $R^{i}(ayxzt)$ *or* $R^{i}(ayzxt)$. Hence (cf. *1·31), there are interpoints C and D, such that *either* $R_{in}{}^{i}(BCDt)$ *or* $R^{i}(CBDt)$ *or* $R^{i}(CDBt)$. Hence B is a member of $R_{in}{}^{i}(;;;t)$.

The theory of interpoints has its chief interest when the following axiom is satisfied. It is named intpnt H*p* R.

*1·41. Intpnt H*p* R is the statement that *if* A *be an interpoint at the instant t, and a be any member of* A, *then* A *is a member of* $R^{i}(a???t)$. In symbols,

$$\text{Intpnt H}p\text{ R} \;.=.\; :A \in \text{intpnt}_{Rt} \;.\; a \in A \;.\supset_{a, A, t}.\; A \in R^{i}(a???t) \qquad \text{Df}$$

*1·42. *Proposition.*—Assuming intpnt H*p* R, then if A and B are distinct members of intpnt_{Rt}, A and B have *either* no members in common *or* one only. In symbols,

$$\vdash .\therefore \text{intpnt H}p\text{ R} \;.\supset : A, B \in \text{intpnt}_{Rt} \;.\; A \neq B \;.\supset. A \cap B \in 0 \cup 1.$$

Proof.—Cf. *1·23·41.

The interest of the relation of interpoint-order (R_{in}) arises when the relation R satisfies four axioms specifying the idea that $R^{i}(abcdt)$ expresses that *a intersects b, c, d in the order bcd.* These axioms (together with intpnt H*p* R) will be employed both in Concept IV and in Concept V. They will be named α H*p* R, β H*p* R, γ H*p* R, δ H*p* R.

*1·51. α H*p* R is the statement that *a is not a member of* $R^{i}(a;;;t)$. In symbols,

$$\alpha\,\text{H}p\,\text{R} \;.=.\; (a, t) \;.\; a \backsim \in R^{i}(a;;;t) \qquad \text{Df}$$

*1·52. β H*p* R is the statement that $R^{i}(abcdt)$ *implies* $R^{i}(adcbt)$. In symbols,

$$\beta\,\text{H}p\,\text{R} \;.=.\; :(a, b, c, d, t) : R^{i}(abcdt) \;.\supset.\; R^{i}(adcbt) \qquad \text{Df}$$

*1·53. γ H*p* R is the statement that R^i(*abcdt*) *and* R^i(*acdbt*) *are inconsistent.* In symbols,

$$\gamma \text{ H}p \text{ R} . = : (a, b, c, d, t) : \text{R}^i(abcdt) . \supset . \backsim \text{R}^i(acdbt) \qquad \text{Df}$$

*1·54. δ H*p* R is the statement that R^i(*abcdt*) *implies that b and d are distinct.* In symbols,

$$\delta \text{ H}p \text{ R} . = : (a, b, c, d, t) : \text{R}^i(abcdt) . \supset . b \neq d \qquad \text{Df}$$

*1·61. *Proposition.*—Assuming (α, β, γ, δ) H*p* R, then R^i(*abcdt*) implies that *a*, *b*, *c*, *d* are all distinct. In symbols,

$$\vdash \therefore (\alpha, \beta, \gamma, \delta) \text{ H}p \text{ R} . \supset : \text{R}^i(abcdt) . \supset . a \neq b . a \neq c . a \neq d . b \neq c . b \neq d . c \neq d$$

*1·62. *Proposition.*—Assuming (α, β, γ, δ) H*p* R, then $\text{R}_{\text{in}}{}^i$(BCD*t*) implies that B, C, D are all distinct. In symbols,

$$\vdash \therefore (\alpha, \beta, \gamma, \delta) \text{ H}p \text{ R} . \supset : \text{R}_{\text{in}}{}^i(\text{BCD}t) . \supset . \text{B} \neq \text{C} . \text{B} \neq \text{D} . \text{C} \neq \text{D}$$

Proof.—By definition (cf. *1·31) $\text{R}_{\text{in}}{}^i$(BCD*t*) implies that *a*, *x*, *y*, *z* exist such that B, C, D are members of R^i(*a*???*t*), *x* is a member of B, *y* of C, *z* of D, and R^i(*axyzt*). Hence (cf. *1·61) *a*, *x*, *y*, *z* are distinct. Now if any two of B, C, D are identical, e.g., B and C, then *x* and *y* are both members of B. Hence (cf. *1·12·21), since *a* is distinct from *x* and *y*, *x* can be substituted for *y* in R^i(*axyzt*). Hence R^i(*axxzt*), which contradicts *1·61.

*1·63. *Proposition.*—Assuming β H*p* R, then $\text{R}_{\text{in}}{}^i$(BCD*t*) implies $\text{R}_{\text{in}}{}^i$(DCB*t*). In symbols,

$$\vdash \therefore \beta \text{ H}p \text{ R} . \supset : \text{R}_{\text{in}}{}^i(\text{BCD}t) . \supset . \text{R}_{\text{in}}{}^i(\text{DCB}t)$$

Proof.—Cf. *1·31·52.

*1·64. *Proposition.*—Assuming (α, β, γ, δ) H*p* R, then $\text{R}_{\text{in}}{}^i$(BCD*t*) and $\text{R}_{\text{in}}{}^i$(CDB*t*) are inconsistent. In symbols,

$$\vdash \therefore (\alpha, \beta, \gamma, \delta) \text{ H}p \text{ R} . \supset : \text{R}_{\text{in}}{}^i(\text{BCD}t) . \supset . \backsim \text{R}_{\text{in}}{}^i(\text{CDB}t)$$

Proof.—$\text{R}_{\text{in}}{}^i$(BCD*t*) implies (cf. *1·31) that *a*, *x*, *y*, *z* exist such that *a* is a common member of B, C, D, *x* is a member of B, *y* of C, *z* of D, and R^i(*axyzt*), and B, C, D are members of R^i(*a*???*t*). Hence (cf. *1·61) *a*, *x*, *y*, *z* are all distinct. Similarly also if $\text{R}_{\text{in}}{}^i$(CDB*t*), then *a*′, *x*′, *y*′, *z*′ exist with similar properties, viz., *x*′ a member of B, &c., except that

$R_i(a'y'z'x't)$. Hence (cf. *1·23·62) a and a' are identical. Thus $R_i(axyzt)$ and $R_i(ay'z'x't)$. But (cf. *1·21) x can be substituted for x', y for y', and z for z'. Hence $R_i(axyzt)$ and $R_i(ayzxt)$. But this contradicts γ H*p* R.

*1·65. *Proposition.*—Assuming (intpnt, α, β, γ, δ) H*p* R, the classes $R_i(;\cdots t)$ and $R_i(;;;;t)$ are identical. In symbols,

$$\vdash : (\text{intpnt}, \alpha, \beta, \gamma, \delta)\ \text{H}p\ \text{R} \,.\supset.\, R_i(;\cdots t) = R_i(;;;;t)$$

Proof.—If x is a member of $R_i(\cdot;;;t)$, y exists such that x is a member of $R_i(y;;;t)$; also (cf. *1·61) x and y are distinct. Hence (cf. *1·21) P exists such that it is a member of $R_i(y???t)$, and x is a member of it. Hence (cf. *1·41) P is a member of $R_i(x???t)$, and hence (cf. *1·21) y is a member of $R_i(x;;;t)$. Hence x is a member of $R_i(;\cdots t)$.

*1·71. *Proposition.*—Assuming α H*p* R, every interpoint possesses at least two members. In symbols,

$$\vdash .\therefore \alpha\ \text{H}p\ \text{R} \,.\supset: \text{A} \in \text{intpnt}_{R_i} \,.\supset.\, \text{N}c`\text{A} \geqq 2$$

Proof.—Cf. *1·13·21·22·51.

*1·72. *Proposition.*—Assuming (intpnt, α, β, γ, δ) H*p* R, then on every objective real there exist at least three interpoints. In symbols,

$$\vdash .\therefore (\text{intpnt}, \alpha, \beta, \gamma, \delta)\ \text{H}p\ \text{R} \,.\supset: a \in R_i(;;;;t) \,.\supset.\, \text{N}c`R_i(a???t) \geqq 3$$

Proof.—Cf. *1·21·31·62·65.

*1·73. *Proposition.*—Assuming (intpnt, α, β, γ, δ) H*p* R, then, if there are any objective reals, the interpoints are not all on any one objective real. In symbols,

$$\vdash .\therefore (\text{intpnt}, \alpha, \beta, \gamma, \delta)\ \text{H}p\ \text{R} \,.\supset: \exists!R_i(;;;;t) \,.\supset.\, \exists!\{\text{intpnt}_{R_i} - R_i(a???t)\}$$

Proof.—Cf. *1·42·71·72.

(iii) Concept IV

*2. This concept bifurcates into two alternate forms, namely IVA and IVB. Concept IVB is related to IVA just as Concept II is related to the classical concept. Thus Concept IVA is dualistic, and Concept IVB is the monistic variant of it. Both concepts can initially be considered together as Concept IV. In Concept IV the essential relation (R) is pentadic, one of the terms being an instant of time. $R_i(abcdt)$ can be read as a intersects b, c and d, in the order bcd at the instant t. The class of those entities, appearing among the first four terms in any

instance of the relation holding, is called the class (O) of 'linear objective reals.' The remaining class of objective reals, required for Concept IVA, is called the class of 'particles.'

The geometrical points of this concept are simply the interpoints of R, as defined above (cf. *1). During the consideration of this concept they will be called *points*. The further definitions, beyond those of *1, required for a concise statement of the geometrical axioms are almost exactly those of Concept I, with the R_{in} of this Concept IV written for the R of Concept I, and modified by the mention of t, as in Concept III. This mention of t can be managed in a similar (though not identical) way to that in Concept III by writing

$$*2{\cdot}01. \qquad R_t{}^i(ABC) = R_{in}{}^i(ABC\iota) \qquad \text{Df}$$

Then the definitions of Concept I will be assumed to apply to R_t. For example, the *punctual line joining the points* A *and* B is the class of points which is the logical sum of $R_t{}^i(;AB)$ and $R_t{}^i(A;B)$ and $R_t{}^i(AB;)$ together with A and B themselves. Its symbol is $R_t{}^i\overline{AB}$. The definition in symbols is

$$R_t{}^i\overline{AB} = R_t{}^i(;AB) \cup R_t{}^i(A;B) \cup R_t{}^i(AB;) \cup \iota'A \cup \iota'B \qquad \text{Df}$$

It will follow (cf. *1·23·31) from the axioms that a punctual line is the class of those points with some member of O as sole common member. The other definitions can be managed in like manner, only in the symbolism a suffix to a suffix will be avoided by writing $\triangle_{R\iota}{}^i(ABC)$, and so on, instead of $\triangle_{R_\iota}{}^i(ABC)$, and so on.

The Axioms.—The earlier axioms have to be modified from those of Concept I, but the later axioms are simply those of Concept I with the R of that concept replaced by the R_t of Concept IV.

$$\text{I } Hp\ R\ .\ =\ :t \in T\ .\supset_t .\ O \subset R^i(;;;;t) \qquad \text{Df}$$

$$\text{II } Hp\ R\ .\ =\ .\ \exists!R^i(\cdots;) \text{ [i.e., } \exists!T] \qquad \text{Df}$$

$$\text{III } Hp\ R\ .\ =\ .\ \alpha\ Hp\ R \qquad \text{Df} \quad \text{(cf. *1·51)}$$

$$\text{IV } Hp\ R\ .\ =\ .\ \beta\ Hp\ R \qquad \text{Df} \quad \text{(cf. *1·52)}$$

$$\text{V } Hp\ R\ .\ =\ .\ \gamma\ Hp\ R \qquad \text{Df} \quad \text{(cf. *1·53)}$$

$$\text{VI } Hp\ R\ .\ =\ .\ \delta\ Hp\ R \qquad \text{Df} \quad \text{(cf. *1·54)}$$

$$\text{VII } Hp\ R\ .\ =\ .\ \text{intpnt } Hp\ R \qquad \text{Df} \quad \text{(cf. *1·41)}$$

VIII Hp R . = $\therefore$ (A, B, C) $\therefore$ A, B, C $\in$ $R_t{}^i(;;;)$. A $\neq$ B . A $\neq$ C . B $\neq$ C . $\exists!$(A $\cap$ B $\cap$ C) . $\supset$: $R_t{}^i$(ABC) . $\vee$. $R_t{}^i$(BCA) . $\vee$. $R_t{}^i$(CAB) Df

IX Hp R . = : (A, B) : A, B $\in$ $R_t{}^i(;;;)$. A $\neq$ B . $\supset$. $\exists!R_t{}^i$(AB;) Df

X Hp R . = : (A, B, C, D, E) : $\triangle_{R_t{}^i}$(ABC) . $R_t{}^i$(BCD) . $R_t{}^i$(CEA) . $\supset$. $\exists!\{R_t{}^i\overline{DE} \cap R_t{}^i(A;B)\}$ Df

XI Hp R . = : $t \in T$. $\supset_t$. ($\exists p$, D) . $p \in \text{ple}_{R_t}$. D $\in$ $R_t{}^i(;;;)$ Sm p Df

XII Hp R . = . ($\exists$ A, B, C, D) . $R_t{}^i(;;;) \subset \Pi_{R_t}$(ABCD) Df

XIII Hp R . = . the axiom of continuity, cf. XII Hp R of Concept I Df

XIV Hp R . = $\therefore \alpha \in \text{ple}_{R_t}$. $a \in \text{lin}_{R_t} \cap \text{cls}'\alpha$. $\supset_{\alpha, a}$: ($\exists$C) : C $\in \alpha$: $l, l' \in \text{lin}_{R_t} \cap \text{cls}'\alpha$. C $\in l \cap l'$. $l \cap a = \Lambda$. $l' \cap a = \Lambda$. $\supset_{l, l'}$. $l = l'$ Df

Note that only I Hp R and XI Hp R require the hypothesis $t \in$ T; in all the other axioms there is a hypothesis which can only be true when $t \in$ T. For the purpose of comparison with the axioms of Concept I, the following propositions are required:—

*2·11. $\vdash \therefore$ (III, IV, V, VI, VII) Hp R . $\supset$: $t \in$ T . $\supset$. Nc'$R_t{}^i(;;;) \geqq 2$

Proof.—Cf. *1·72.

*2·21. $\vdash \therefore$ IV Hp R . $\supset$: $R_t{}^i$(ABC) . $\supset$. $R_t{}^i$(CBA)

Proof.—Cf. *1·63.

*2·22. $\vdash \therefore$ (III, IV, V, VI) Hp R . $\supset$: $R_t{}^i$(ABC) . $\supset$. $\backsim R_t{}^i$(BCA)

Proof.—Cf. *1·64.

*2·23. $\vdash \therefore$ (III, IV, V, VI) Hp R . $\supset$: $R_t{}^i$(ABC) . $\supset$. A $\neq$ C

Proof.—Cf. *1·62.

*2·31. *Proposition.*—Assuming (VII, IX) Hp R, if A and B are two distinct points at the time t, they possess one, and only one, common member. In symbols,

$\vdash \therefore$ (VII, IX) Hp R . $\supset$: A, B $\in$ $R_t{}^i(;;;)$. A $\neq$ B . $\supset$. A $\cap$ B $\in$ 1

Proof.—Cf. *1·31·42 and (VII, IX) Hp R.

*2·32. *Proposition.*—Assuming (VII, VIII, IX) Hp R, a line at any instant t (i.e., a member of lin_{R_t}) is the complete class of points (inter-points) possessing some linear objective real. In symbols,

$\vdash$: (VII, VIII, IX) H*p* R . ⊃ . $\text{lin}_{R_t} = \dot{p}[(\exists a) . a \in R_t(;;;;t) . p = \dot{\Lambda}\{A \in R_t(;;;) . a \in A\}]$

Proof.—Cf. VIII H*p* R and *2·31.

Propositions *2·31·32 effect the identification of the punctual line, as defined above, and the class of points on some linear objective real. Thus a straight line considered as an entity with parts is a punctual line, and considered as a simple unit is a linear objective real.

*2·33. *Proposition.*—Assuming (VII, VIII, IX) H*p* R, if C and D are two points in the punctual line $R_t\overline{AB}$, then A is a point in the punctual line $R_t\overline{CD}$. In symbols,

$\vdash .\therefore$ (VII, VIII, IX) H*p* R . ⊃ : C, D $\in R_t\overline{AB}$. C $\neq$ D . ⊃ . A $\in R_t\overline{CD}$

Proof.—Cf. *2·32.

*2·41. $\vdash .\therefore$ (III–IX) H*p* R . ⊃ : $t \in T$. ⊃ . ($\exists$ A, B, C) . $\triangle_{R_t}$(ABC)

Proof.—Cf. *1·72·73. *2·32.

*2·5. *Proposition.*—Assuming (III–XIV) H*p* R of Concept IV, then all the axioms of Concept I hold when the R_t of Concept IV is substituted for the R of Concept I, and *t* is a member of T.

Proof.—Cf. *2·11·21·22·23·33·41 and (IX–XIV) H*p* R (of Concept IV) and (I–XII) H*p* R of Concept I.

It will be noticed that I H*p* R (of Concept IV) is not required in the above comparison. It does not belong to the purely geometrical side of the concept, but is a necessary part of the 'physical' ideas. II H*p* R (of Concept IV), though it does not occur explicitly in the above comparison, is required to give the geometry 'existence.' Thus the geometry of Concept IV requires thirteen axioms.

For the purpose of the transition to projective geometry (cf. Veblen, *loc. cit.*), it is now unnecessary to conceive a new class of 'projective points.' The points already on hand are exactly the entities required. All that is necessary is to define the class of those linear objective reals (cf. XIV H*p* R), coplanar with any given linear objective real and not intersecting it, as *the point at infinity* on that objective real. Then with these new points at infinity, and the old points, the complete set of 'projective points' is obtained.

The Extraneous Relation.—For the purpose of the definition of motion, one extraneous tetradic relation is required, exactly as in Concept III. Also the same hypotheses must hold respecting it. The

three mutually rectangular and intersecting punctual lines, thus indicated at each instant, are to be taken as the 'kinetic axes,' and all motion measured by reference to them. A given set of kinetic axes does not, in general, correspond to the same three linear objective reals at different instants of time.

Matter.—It is necessary to assume that the points in this concept disintegrate, and do not, in general, persist from instant to instant. For otherwise the only continuous motion possible would be representable by linear transformations of coordinates; and it seems unlikely that sense-perceptions could be explained by such a restricted type of motions. We have therefore to consider what, in this concept, can represent the permanence of matter. A 'corpuscle,' as we may call it, may be conceived to be a volume with some special property in respect to the linear objective reals 'passing through' it. This is the procedure adopted in Concept V; and the methods of overcoming the obvious difficulties which suggest themselves will be considered in detail there. It is sufficient here to notice that, in this Concept IV, the special property of the volume must relate merely to the motion of the objective reals. For the only alternative is to make the property consist of the permanence of the points within the volume. But then the difficulty of permanent collineations, mentioned above, recurs. To find a special property of motion, we require a kinematical science for linear objective reals in this concept analogous to the kinematical parts of hydrodynamics. In the absence at the present time of such a science, we proceed to other alternatives.

Concept IV$_A$.—Conceive a class of *particles*, each particle being associated at each instant with some point, but not necessarily each point with some particle. Then the particles represent the 'matter' which 'occupies' space. Laws of motion must then be stated (i) for the particles and (ii) for the linear objective reals. Also the motion of the particles may be conceived to be influenced by that of the linear objective reals, and *vice versâ*. The endeavour to state such laws appears to reduce itself to rewriting with appropriate changes a chapter of any modern treatise of electricity and magnetism. It would seem necessary to subdivide the class of particles into 'positive' and 'negative' particles, a charged volume containing an excess of one type. The conception of an ether conveying lines of force is replaced by the class of the linear objective reals. The details can be managed much as in the analogous case of Concept V., considered later. An indefinite number of extraneous

relations are required to 'locate' the particles, just as in Concept I. This concept (as thus developed with 'particles') is not completely a 'linear' concept. It is a hybrid between the 'linear' and 'punctual' concepts. In its dualism it is not superior to the classical concept. But, in possessing moving linear objective reals as well as moving particles, it is richer in physical ideas.

Concept IVB.—In this concept, just as in Concept II., each triadic extraneous relation of Concept IVA. between an instant of time, a particle, and a point is replaced by a dyadic extraneous relation between a point and an instant of time.

PART IV (i) *THE THEORY OF DIMENSIONS*

*3. Concept V. depends upon a treatment of the theory of dimensions different from that which at present obtains. The theory here developed is relevant to any definite property which (1) is a property of classes only, and (2) is only a property of some classes. It will be clearer, and no longer, to explain the theory in its full generality, and in Concept V. to make the special application required.

This general theory of dimensions may, perhaps, have a range of importance greater than that which is assigned to it in the sequel. In *10 a set of hypotheses are given respecting the property ϕ; and when these are true of ϕ, the propositions and definitions of *3 to *8 acquire importance and emerge from triviality, also in this case further deductions of propositions can be made. The Concept V. to which this theory is applied is explained in the definitions of *20 and the axioms of *22. In this Concept V. a special property ϕ is taken, which is termed 'Homaloty' (cf. *20·11·12), and (cf. *22) in the axioms a relation R is considered such that 'homaloty,' defined in respect to R, has the properties of the axioms in *10.

*3·01. *Definition.*—If $\phi!x$ is some proposition involving the entity x, which may be varied, so that $\phi!x$ and $\phi!y$ make the same statement (ϕ) about x and y respectively, then any entity z, for which $\phi!z$ is true, is said to *possess the property* ϕ.

*3·02. *Definition.*—A *ϕ-class* is a class with the property ϕ, that is to say, if u is a ϕ-class, then $\phi!u$ is true.

*3·11. *Definition.*—The *ϕ-region* is the logical sum of all classes which possess the property ϕ. The symbol O_ϕ will denote the ϕ-region. The symbol definition is

$$O_\phi = \cup`\dot{u}\{\phi!u\} \qquad \text{Df}$$

*3·12. The *common ϕ-subregion for u* is that class which is the common subclass of all ϕ-classes with the class u as a subclass. The symbol $cm_\phi`u$ will denote the common ϕ-subregion for u. The symbolic definition is

$$cm_\phi`u = \cap`\dot{v}\{\phi!v \,.\, u \in cls`v\} \qquad \text{Df}$$

Note.—If no class v, with the property ϕ and containing u as a subclass, exists, then $cm_\phi`u$ will be the class of all entities. But if a class $v$ exists which has the property $\phi$ and contains $u$, then $cm_\phi`u$ is a subclass of O_ϕ. In the sequel it will be found that this latter is the only relevant case for our purposes.

Elucidatory Note.—Assuming our ordinary geometrical ideas, let the property of the 'flatness' of a class of straight lines be defined thus: A class of straight lines is flat, *either*, when it is a necessary and sufficient condition for membership that a straight line meets two members of the class, not at their point of meeting, *or*, when the class is a unit class with one line as its sole member. Thus a plane (as a line-locus) is flat, a three-dimensional space (as a line-locus) is flat, and so on. Now let the property ϕ in the above definition be the property of flatness. If then u is a class consisting only of two straight lines, the common ϕ-subregion for u is either a three-dimensional space or a plane, according as the two lines are not, or are, coplanar. Also in a space of higher dimensions than three, if u be a class consisting of three straight lines, the common ϕ-subregion for u may be either (1) a plane, or (2) a three-dimensional space, or (3) a four-dimensional space, or (4) a five-dimensional space, according to the circumstances of the lines. It will be noticed that, in the application of this theory of the common ϕ-subregion to the particular case of geometrical flatness, the common ϕ-subregion of any class of lines is itself flat. But this is not, in general, the case when any property not flatness is considered. It is this peculiar property of flatness which has masked the importance in geometry of the theory of common ϕ-subregions.

*3·121. *Definition.*—Two classes u and v have *ϕ-equivalence* if $cm_\phi`u = cm_\phi`v$. The class of those classes (including u itself as a mem-

ber), which have ϕ-equivalence with u, is denoted by equiv_ϕ‘u. The symbolic definition is

$$\text{equiv}_\phi\text{‘}u = \dot{v}(\text{cm}_\phi\text{‘}v = \text{cm}_\phi\text{‘}u) \qquad \text{Df}$$

*3·13. *Definition.*—A class u (not the null class) is *ϕ-prime*, when, if v be any proper part (part, not the whole) of u, v is *not* ϕ-equivalent to u. The class of those classes which are ϕ-prime will be denoted by the symbol prm_ϕ. The symbolic definition is

$$\text{prm}_\phi = \dot{u}\{\exists!u : v \subset u \,.\, \exists!(u - v) \,.\supset_\rho.\, \text{cm}_\phi\text{‘}v \neq \text{cm}_\phi\text{‘}u\} \qquad \text{Df}$$

Elucidatory Note.—With the assumptions of the elucidatory note on cm_ϕ‘u, it is at once obvious that two straight lines form a ϕ-prime (where ϕ is flatness) class, whether they are or are not coplanar. But if u consist of three straight lines, (1) u is not ϕ-prime if cm_ϕ‘u is a plane, (2) u is not, in general, ϕ-prime if cm_ϕ‘u is a space of three dimensions, but u is (in this case) ϕ-prime if the three lines are concurrent, (3) u is ϕ-prime if cm_ϕ‘u is of four dimensions, (4) u is ϕ-prime if cm_ϕ‘u is of five dimensions.

*3·21. The *ϕ-dimension number* (or the *ϕ-dimensions*) of a class u is the greatest of the cardinal numbers of all classes (including possibly u itself) which are both ϕ-equivalent to u and ϕ-prime. The ϕ-dimension number of u will be denoted by $\dim_\phi$‘u. The symbolic definition is

$$\dim_\phi\text{‘}u \,.=: (\imath\alpha) : \alpha \in \text{Nc}\text{“}(\text{prm}_\phi \cap \text{equiv}_\phi\text{‘}u) : \rho \in \text{Nc}\text{“}(\text{prm}_\phi \cap \text{equiv}_\phi\text{‘}u) \,.\supset_\rho.\, \rho \leqq \alpha \qquad \text{Df}$$

Elucidatory Note.—With the assumptions of the previous elucidatory notes (where ϕ is flatness), we see that those ϕ-prime classes, the common ϕ-subregions for which are spaces of three dimensions (as ordinarily understood), are all pairs of non-intersecting lines and all trios of concurrent non-coplanar lines; also no class of four lines in such a space can be prime. Thus three is the greatest cardinal number of any ϕ-prime class of lines for which the common ϕ-subregion is such a space. Hence, according to the above definition, three is the ϕ-dimension number of the space.

*3·22. *Definition.*—A class u is *ϕ-axial* when (1) it is ϕ-prime and (2) its cardinal number is equal to its ϕ-dimensions. The class of ϕ-axial classes is denoted by the symbol ax_ϕ. The symbolic definition is

$$\text{ax}_\phi = \dot{u}\{u \in \text{prm}_\phi \cap \dim_\phi\text{‘}u\} \qquad \text{Df}$$

Elucidatory Note.—With the assumptions of the previous elucidatory notes (where ϕ is flatness), we see that two coplanar lines form a ϕ-axial class, and so also do three concurrent non-coplanar lines.

*3·23. *Definition.*—A class u is *ϕ-maximal* when (1) all those of its subclasses (possibly including u itself), which are both ϕ-prime and ϕ-equivalent to u, are ϕ-axial, and (2) there are such subclasses. The class of ϕ-maximal classes will be denoted by mx_ϕ. The symbolic definition is

$$\mathrm{mx}_\phi = \dot{u}\{\exists!(\mathrm{prm}_\phi \cap \mathrm{equiv}_\phi{}'u \cap \mathrm{cls}'u) \,.\, \mathrm{prm}_\phi \cap \mathrm{equiv}_\phi{}'u \cap \mathrm{cls}'u \subset \mathrm{ax}_\phi\} \quad \text{Df}$$

Elucidatory Note.—Referring to the previous elucidatory notes (where ϕ is flatness), we see that any set of coplanar lines form a ϕ-maximal class; similarly any set of concurrent lines form a ϕ-maximal class.

*3·31. *Definition.*—The *ϕ-concurrence* of u and v, where u and v are classes, is that subclass of u (possibly u itself), such that any couple, formed by any member of it and any member of v, is ϕ-axial. The ϕ-concurrence of u with v is denoted by the symbol $\tilde{u}_\phi{}'v$. The definition in symbols is

$$\tilde{u}_\phi{}'v = \dot{x}\{x \in u : y \in v \,.\, \supset_y \,.\, \iota'x \cup \iota'y \in \mathrm{ax}_\phi\} \quad \text{Df}$$

The ϕ-concurrence of the ϕ-region (O_ϕ) with any class v will be written $\tilde{\mathrm{O}}_\phi{}'v$ instead of $\tilde{\mathrm{O}}_{\phi_\phi}{}'v$.

Elucidatory Note.—Referring to the previous elucidatory notes (when ϕ is flatness), we see that, when u and v are classes of straight lines, $\tilde{u}_\phi{}'v$ (i.e., the ϕ-concurrence of u with v) is that complete set of lines of u which is such that any member of it is coplanar with every member of v.

*3·32. *Definition.*—A class u is a *self-ϕ-concurrence* if the ϕ-concurrence of u with itself is the whole class u. The class of those classes which are self-ϕ-concurrences will be denoted by conc_ϕ. The symbolic definition is

$$\mathrm{conc}_\phi = \dot{u}\{u = \tilde{u}_\phi{}'u\} \quad \text{Df}$$

*3·33. *Definition.*—x will be said to be *ϕ-concurrent with y*, if the class composed of x and y only (i.e., the class $\iota'x \cup \iota'y$) is ϕ-axial.

*3·41. *Definition.*—A *ϕ-plane* is a class u such that there exists a class v, which (1) is ϕ-axial, (2) is composed of two members only, and (3) is such that u is the class $\mathrm{cm}_\phi{}'v$. The class of those classes which are ϕ-planes is denoted by ple_ϕ. The symbolic definition is

$$\text{ple}_\phi = \dot{u}\{(\exists v) \,.\, v \in 2 \cap \text{ax}_\phi \,.\, u = \text{cm}_\phi\text{`}v\} \qquad \text{Df}$$

Note.—It requires an axiom to establish that a ϕ-plane is a self-ϕ-concurrence (cf. *16·11).

*3·42. *Definition.*—A class u is a *ϕ-point*, if there exists a class v, which (1) is ϕ-axial, (2) is composed of three members only, and (3) is such that u is the ϕ-concurrence of the ϕ-region with v. The class of those classes which are ϕ-points is denoted by the symbol pnt_ϕ. The symbolic definition is

$$\text{pnt}_\phi = \dot{u}\{(\exists v) \,.\, v \in 3 \cap \text{ax}_\phi \,.\, u = \tilde{O}_\phi\text{`}v\} \qquad \text{Df}$$

Note.—It requires axioms to establish that a ϕ-point is ϕ-maximal and is a self-ϕ-concurrence (cf. *14·11·12). Also note that this definition does not apply unless the number of dimensions of O_ϕ is at least three, but then applies *unchanged* however great this number may be.

Elucidatory Note.—Referring to the previous elucidatory notes (where ϕ is flatness), we see that a ϕ-point now becomes simply that class of straight lines concurrent at a point. The analogy with Klein's 'ideal,' or 'projective,' points is obvious. Only when the present theory is applied, it will be found that the original 'descriptive' point has entirely vanished.

*3·43. *Definition.*—A class is *ϕ-coplanar* if there exists a ϕ-plane of which it is a subclass. The symbol $\text{cople}_\phi!u$ denotes that the class u is ϕ-coplanar. The definition in symbols is

$$\text{cople}_\phi!u \,.\, = \,.\, (\exists p) \,.\, p \in \text{ple}_\phi \,.\, u \in \text{cls}\text{`}p \qquad \text{Df}$$

*3·44. *Definition.*—A class is *ϕ-copunctual* if there exists a ϕ-point of which it is a subclass. The symbol $\text{copnt}_\phi!u$ denotes that the class u is ϕ-copunctual. The definition in symbols is

$$\text{copnt}!u \,.\, = \,.\, (\exists P) \,.\, P \in \text{pnt}_\phi \,.\, u \in \text{cls}\text{`}P \qquad \text{Df}$$

General Deductions Concerning Dimensions

A large chapter of interesting propositions concerning the entities defined above in *3 can be compiled. The following are chosen as being directly wanted in the subsequent investigations:—

*4. *On Common ϕ-subregions.*

*4·21. *Proposition.*—If v is a subclass of u, then $\text{cm}_\phi\text{`}v$ is a subclass of $\text{cm}_\phi\text{`}u$. In symbols,

$$\vdash : v \subset u \,.\, \supset \,.\, \text{cm}_\phi\text{`}v \subset \text{cm}_\phi\text{`}u$$

Proof.—Cf. *3·12.

*4·25. *Proposition.*—A class u is itself a subclass of $\mathrm{cm}_\phi{}'u$. In symbols

$$\vdash . u \subset \mathrm{cm}_\phi{}'u$$

Proof.—Cf. *3·12.

*4·27. *Proposition.*—If u is a class with the property ϕ, then u is identical with $\mathrm{cm}_\phi{}'u$. In symbols,

$$\vdash : \phi!u . \supset . u = \mathrm{cm}_\phi{}'u$$

Proof.—Cf. *3·12.

*4·28. *Proposition.*—If there exist two classes, both with the property ϕ, which possess no common member, then $\mathrm{cm}_\phi{}'\Lambda$ is itself the null class (Λ). In symbols,

$$\vdash : (\exists\, u, v) . u \cap v = \Lambda . \phi!u . \phi!v . \supset . \mathrm{cm}_\phi{}'\Lambda = \Lambda$$

Proof.—Note that $\mathrm{cm}_\phi{}'\Lambda$ is the common part of all ϕ-classes.

Corollary.—If x and y exist such that they are distinct, and the two unit classes with them as members respectively each have the property ϕ, then $\mathrm{cm}_\phi{}'\Lambda$ is Λ.

Note that when *4·28 is appealed to, it will be this corollary which is directly used.

*4·31. *Proposition.*—The common ϕ-subregion for the common ϕ-subregion for u is the common ϕ-subregion for u. In symbols,

$$\vdash . \mathrm{cm}_\phi{}'\mathrm{cm}_\phi{}'u = \mathrm{cm}_\phi{}'u$$

Proof.—For $\mathrm{cm}_\phi{}'u$ is contained in every ϕ-class containing u. Hence (cf. *3·12) $\mathrm{cm}_\phi{}'\mathrm{cm}_\phi{}'u$ is contained in $\mathrm{cm}_\phi{}'u$. Also (cf. *4·25·21) $\mathrm{cm}_\phi{}'u$ is contained in $\mathrm{cm}_\phi{}'\mathrm{cm}_\phi{}'u$.

*4·32. *Proposition.*—If u and v are ϕ-equivalent, and w is any class, then the common ϕ-subregion for the logical sum of u and w is identical with the common ϕ-subregion for the logical sum of v and w. In symbols,

$$\vdash : \mathrm{cm}_\phi{}'u = \mathrm{cm}_\phi{}'v . \supset . \mathrm{cm}_\phi{}'(u \cup w) = \mathrm{cm}_\phi{}'(v \cup w)$$

Proof.—For (cf. *4·21) $\mathrm{cm}_\phi{}'v$ is contained in $\mathrm{cm}_\phi{}'(v \cup w)$, and hence (*hypothesis*) $\mathrm{cm}_\phi{}'u$ is contained in $\mathrm{cm}_\phi{}'(v \cup w)$, and hence (cf. *4·25) $u \cup w$ is contained in $\mathrm{cm}_\phi{}'(v \cup w)$, and hence (cf. *4·21) $\mathrm{cm}_\phi{}'(u \cup w)$ is contained in $\mathrm{cm}_\phi{}'\mathrm{cm}_\phi{}'(v \cup w)$, and hence (cf. *4·31) $\mathrm{cm}_\phi{}'(u \cup w)$ is contained in $\mathrm{cm}_\phi{}'(v \cup w)$. Then interchanging u and v, and combining the two results, the proposition follows.

The following propositions are not cited subsequently, so their verbal enunciations are omitted:—

*4·41. $\vdash . \mathrm{cm}_\phi`(\mathrm{cm}_\phi`u \cap \mathrm{cm}_\phi`v) = \mathrm{cm}_\phi`u \cap \mathrm{cm}_\phi`v$

*4·42. $\vdash . \cap`\mathrm{cm}_\phi``p = \mathrm{cm}_\phi` \cap `\mathrm{cm}_\phi``p$

*4·43. $\vdash . \mathrm{cm}_\phi`(\mathrm{cm}_\phi`u \cup \mathrm{cm}_\phi`v) = \mathrm{cm}_\phi`(u \cup v)$

*4·44. $\vdash . \mathrm{cm}_\phi` \cup `\mathrm{cm}_\phi``p = \mathrm{cm}_\phi` \cup `p$

*5. *On ϕ-Primes.*

*5·23. *Proposition.*—If u is a ϕ-prime, and v is a subclass of u, and is not the null class, then v is a ϕ-prime. In symbols,

$$\vdash : u \in \mathrm{prm}_\phi . v \in \mathrm{cls}`u . \exists ! v . \supset . v \in \mathrm{prm}_\phi$$

Proof.—For if w be any subclass (not the null class) of v, then (cf. *3·13) $\mathrm{cm}_\phi`(u - w)$ is not $\mathrm{cm}_\phi`u$. But $(u - w)$ can be written $\{(v - w) \cup (u - v)\}$, and u can be written $\{v \cup (u - v)\}$. Hence $\mathrm{cm}_\phi`\{(v - w) \cup (u - v)\}$ is not $\mathrm{cm}_\phi`\{v \cup (u - v)\}$. Hence (cf. *4·32) $\mathrm{cm}_\phi`(v - w)$ is not $\mathrm{cm}_\phi`v$. Hence (cf. *3·13) v is a ϕ-prime.

Note.—This theorem, together with *4·31·32, is the foundation of the whole theory. It is remarkable that it requires no axiom concerning ϕ. The companion theorem (cf. *12·42), with ax_ϕ substituted for prm_ϕ, requires axioms respecting ϕ.

*5·231. *Proposition.*—Necessary and sufficient conditions, that a class u may be ϕ-prime, are: (1) u is not the null class, and (2) if x be any member of u, then $\mathrm{cm}_\phi`(u - \iota`x)$ is not $\mathrm{cm}_\phi`u$. In symbols,

$$\vdash .\therefore \exists ! u : x \in u . \supset_x . \mathrm{cm}_\phi`(u - \iota`x) \neq \mathrm{cm}_\phi`u : \equiv . u \in \mathrm{prm}_\phi$$

Proof.—Cf. *3·13 and *4·21.

*5·233. *Proposition.*—If $\mathrm{cm}_\phi`\Lambda = \Lambda$, then every unit class is a ϕ-prime. In symbols,

$$\vdash : \mathrm{cm}_\phi`\Lambda = \Lambda . \supset . 1 \subset \mathrm{prm}_\phi$$

Proof.—Cf. *3·13 and *4·25.

*5·235. *Proposition.*—If x and y are distinct, and the unit classes $\iota`x$ and $\iota`y$ have the property ϕ, then the class, which is the couple composed of x and y, is a ϕ-prime. In symbols,

$$\vdash : x \neq y . \phi ! \iota`x . \phi ! \iota`y . \supset . \iota`x \cup \iota`y \in \mathrm{prm}_\phi$$

Proof.—Cf. *3·13 and *4·25·27.

*6. *On ϕ-Dimensions and ϕ-Axial Classes.*

*6·23. *Proposition.*—The ϕ-dimension of u, if there is such an entity, is a cardinal number not zero. In symbols,

$$\vdash : (\mathrm{Ex}) (\dim_\phi `u) \,.\supset.\, \dim_\phi `u \in \mathrm{Nc} - \iota `0$$

Proof.—Cf. *3·21.

*6·25. *Proposition.*—If v is a ϕ-prime and has a ϕ-dimension number, then the cardinal number of v is less than, or equal to, $\dim_\phi `v$. In symbols,

$$\vdash : (\mathrm{Ex}) (\dim_\phi `v) \,.\, v \in \mathrm{prm}_\phi \,.\supset.\, \mathrm{Nc} `v \leqq \dim_\phi `v$$

Proof.—Cf. *3·21.

*6·26. *Proposition.*—If v is ϕ-axial and is ϕ-equivalent to u, then the cardinal number of v is equal to $\dim_\phi `u$. In symbols,

$$\vdash : v \in \mathrm{ax}_\phi \cap \mathrm{equiv}_\phi `u \,.\supset.\, \mathrm{Nc} `v = \dim_\phi `u$$

Proof.—Cf. *3·21·22.

*8. *On ϕ-Concurrences.*

*8·21. *Proposition.*—If u is contained in w, then the ϕ-concurrence of u with v is contained in the ϕ-concurrence of w with v. In symbols,

$$\vdash : u \subset w \,.\supset.\, \tilde{u}_\phi `v \subset \tilde{w}_\phi `v$$

Proof.—Cf. *3·31.

*8·22. *Proposition.*—If v is contained in w, then the ϕ-concurrence of u with w is contained in the ϕ-concurrence of u with v. In symbols,

$$\vdash : v \subset w \,.\supset.\, \tilde{u}_\phi `w \subset \tilde{u}_\phi `v$$

Proof.—Cf. *3·31.

*10. *Geometrical Properties.*—A property ϕ is called *geometrical* if it satisfies the five axioms (λ, μ, ν, π, ρ) Hp ϕ stated below. The axiom ν Hp ϕ takes the special form for three dimensions. It is to be noticed that three dimensions is the lowest number for which a ϕ-point (cf. *3·42) can be defined. The reasoning can be applied to higher dimensions, only more elaborate inductions and an extra axiom are required. Other axioms and definitions are wanted to enable all the propositions of projective geometry to be proved. These will not be considered here as such an investigation would involve some repetition when we come to Concept V. The class O_ϕ is the class of straight lines of the geometry, conceived as simple unities. The class pnt_ϕ is the class of points, each

point being a class of lines. The class ple_ϕ is the class of planes, each plane being a class of lines.

*10·1. $\lambda\ \text{Hp}\ \phi$ is the statement that O_ϕ *has the property* ϕ. In symbols,

$$\lambda\ \text{Hp}\ \phi\ .\ =\ .\ \phi!\text{O}_\phi \qquad \text{Df}$$

*10·2. $\mu\ \text{Hp}\ \phi$ is the statement that, *if x is any member of* O_ϕ, *the unit class* $\iota`x$ *has the property* ϕ. In symbols,

$$\mu\ \text{Hp}\ \phi\ .\ =\ :x \in \text{O}_\phi\ .\supset_x .\ \phi!\iota`x \qquad \text{Df}$$

*10·3. $\nu\ \text{Hp}\ \phi$ is the statement that *the ϕ-dimension number of* O_ϕ *is three*. In symbols,

$$\nu\ \text{Hp}\ \phi\ .\ =\ .\ \dim_\phi`\text{O}_\phi = 3 \qquad \text{Df}$$

*10·4. $\pi\ \text{Hp}\ \phi$ is the statement that, *if u is a subclass of* O_ϕ, *and v is ϕ-axial and contained in* $\text{cm}_\phi`u$, *then there exists a class w (possibly the null class) such that the logical sum of v and w is ϕ-axial and ϕ-equivalent to u*. In symbols,

$$\pi\ \text{Hp}\ \phi\ .\ =\ :u \in \text{cls}`\text{O}_\phi\ .\ v \in \text{ax}_\phi \cap \text{cls}`\text{cm}_\phi`u\ .\supset_{u,v} .\ (\exists w)\ .$$
$$v \cup w \in \text{ax}_\phi \cap \text{equiv}_\phi`u \qquad \text{Df}$$

*10·5. $\rho\ \text{Hp}\ \phi$ is the statement that *if u and v are both ϕ-axial, and if they possess at least two members in common, then their logical sum is ϕ-maximal*. In symbols,

$$\rho\ \text{Hp}\ \phi\ .\ =\ :u,\ v \in \text{ax}_\phi\ .\ \text{Nc}`(u \cap v) \geqq 2\ .\supset_{u,v} .\ u \cup v \in \text{mx}_\phi \qquad \text{Df}$$

Elucidatory Note.—Referring to the previous elucidatory notes (where ϕ is flatness), we see that *10·4 in effect assumes that a line can always be added (1) to two concurrent lines to form a set of three concurrent non-coplanar lines, and (2) to one line in a plane to form a set of two concurrent lines in that plane. Also *10·5 assumes that, if two sets of three concurrent lines have two members in common, the four lines are concurrent.

Deductions from the Axioms

*11. *Preliminary Propositions.*

*11·11. *Proposition.*—Assuming $(\lambda,\ \nu)\ \text{Hp}\ \phi$, O_ϕ has at least three members. In symbols,

$$\vdash :(\lambda,\ \nu)\ \text{Hp}\ \phi\ .\supset .\ \text{Nc}`\text{O}_\phi \geqq 3$$

Proof.—Cf. *4·27 and *10·1·3.

*11·12. *Proposition.*—Assuming (λ, μ, ν) $\mathrm{Hp}\,\phi$, $\mathrm{cm}_\phi{}'\Lambda$ is the null class (Λ). In symbols,

$$\vdash : (\lambda, \mu, \nu)\ \mathrm{Hp}\,\phi\ .\supset.\ \mathrm{cm}_\phi{}'\Lambda = \Lambda$$

Proof.—Cf. *4·28 and *10·2 and *11·11.

*11·21. *Proposition.*—Assuming (λ, μ) $\mathrm{Hp}\,\phi$, all ϕ-prime classes with more than one member are contained in O_ϕ. In symbols,

$$\vdash \therefore (\lambda, \mu)\ \mathrm{Hp}\,\phi\ .\supset : \nu \in \mathrm{prm}_\phi\ .\ \mathrm{Nc}'\nu > 1\ .\supset.\ \nu \in \mathrm{cls}'\mathrm{O}_\phi$$

Proof.—For if x is not a member of O_ϕ, then $\mathrm{cm}_\phi{}'\iota'x$ is the class of all entities. Hence (cf. *4·21·27 and *10·1·2) the conclusion follows.

*12. *On ϕ-Axial Classes and ϕ-Dimensions.*

*12·11. *Proposition.*—Assuming (λ, μ, ν) $\mathrm{Hp}\,\phi$, every unit class whose single member belongs to O_ϕ is ϕ-axial. In symbols,

$$\vdash \therefore (\lambda, \mu, \nu)\ \mathrm{Hp}\,\phi\ .\supset : x \in \mathrm{O}_\phi\ .\supset_x.\ \iota'x \in \mathrm{ax}_\phi$$

Proof.—Cf. *3·21·22 and *4·27 and *5·233 and *10·2.

*12·12. *Proposition.*—Assuming $(\lambda - \pi)$ $\mathrm{Hp}\,\phi$, every subclass of O_ϕ, not the null class, has a set of ϕ-axes. (*Note.*—A class which is ϕ-axial and ϕ-equivalent to a class u is said to be *a set of ϕ-axes of u*.) In symbols,

$$\vdash \therefore (\lambda - \pi)\ \mathrm{Hp}\,\phi\ .\supset : u \in \mathrm{cls}'\mathrm{O}_\phi\ .\ \exists!u\ .\supset.\ \exists!(\mathrm{ax}_\phi \cap \mathrm{equiv}_\phi{}'u)$$

Proof.—Since there is at least one member of u, there is (cf. *12·11) a ϕ-axial class contained in u. Hence (cf. *10·4) this class can be augmented so as to become a set of ϕ-axes of u.

*12·13. *Proposition.*—Assuming $(\lambda - \pi)$ $\mathrm{Hp}\,\phi$, if u and v are subclasses of O_ϕ, and v is not the null class, and $\mathrm{cm}_\phi{}'v$ is contained in $\mathrm{cm}_\phi{}'u$, then there exist two subclasses of O_ϕ, w and w', say, such that w is a set of ϕ-axes of v, and $w \cup w'$ is a set of ϕ-axes of u. In symbols,

$$\vdash \therefore (\lambda - \pi)\ \mathrm{Hp}\,\phi\ .\supset : u, v \in \mathrm{cls}'\mathrm{O}_\phi\ .\ \exists!v\ .\ \mathrm{cm}_\phi{}'v \subset \mathrm{cm}_\phi{}'u\ .\supset.$$
$$(\exists w, w')\ .\ w \in \mathrm{ax}_\phi \cap \mathrm{equiv}_\phi{}'v\ .\ w \cup w' \in \mathrm{ax}_\phi \cap \mathrm{equiv}_\phi{}'u.$$

Proof.—Cf. *10·4 and *12·12.

*12·21. *Proposition.*—Assuming $(\lambda - \pi)$ $\mathrm{Hp}\,\phi$, if u and v are subclasses of O_ϕ, and v is not the null class, and $\mathrm{cm}_\phi{}'v$ is contained in $\mathrm{cm}_\phi{}'u$, then the ϕ-dimension number of v is less than, or equal to, the ϕ-dimension number of u. In symbols,

$$\vdash .\therefore (\lambda - \pi)\,\mathrm{H}p\,\phi\,.\supset : u,\, v \in \mathrm{cls}`\mathrm{O}_\phi\,.\,\exists!v\,.\,\mathrm{cm}_\phi`v \subset \mathrm{cm}_\phi`u\,.\supset .\ \dim_\phi`v \leqq \dim_\phi`u.$$

Proof.—From *6·26 and *12·13, w and w' exist (assuming $w \cap w' = \Lambda$) such that $\mathrm{Nc}`w = \dim_\phi`v$ and $\mathrm{Nc}`w + \mathrm{Nc}`w' = \dim_\phi`u$. Hence $\dim_\phi`v < \dim_\phi`u$, unless $w'$ is the null class, or unless the numbers are not finite, in which cases $\dim_\phi`v = \dim_\phi`u$ is possible.

*12·23. *Proposition.*—Assuming $(\lambda - \pi)\,\mathrm{H}p\,\phi$, if u and v are subclasses of O_ϕ, and v is not the null class, and $\mathrm{cm}_\phi`v$ is contained in $\mathrm{cm}_\phi`u$, then, if $\dim_\phi`v = \dim_\phi`u$, we have $\mathrm{cm}_\phi`v = \mathrm{cm}_\phi`u$, and conversely. In symbols,

$$\vdash : : (\lambda - \pi)\,\mathrm{H}p\,\phi\,.\supset .\therefore v,\, u \in \mathrm{cls}`\mathrm{O}_\phi\,.\,\exists!v\,.\,\mathrm{cm}_\phi`v \subset \mathrm{cm}_\phi`u\,.\supset :\ \mathrm{cm}_\phi`v = \mathrm{cm}_\phi`u\,.\equiv.\,\dim_\phi`v = \dim_\phi`u$$

Proof.—Assuming $\dim_\phi`v = \dim_\phi`u$, and also assuming the notation of the proof of *12·21, then w and w' are such that (1) w is ϕ-equivalent to v and $w \cup w'$ to u, (2) $\mathrm{Nc}`w = \dim_\phi`v$ and $\mathrm{Nc}`w + \mathrm{Nc}`w' = \dim_\phi`u$. Hence, by hypothesis and (2), $\mathrm{Nc}`w + \mathrm{Nc}`w' = \mathrm{Nc}`w$. Also (cf. *10·3 and *12·21) $\mathrm{Nc}`w + \mathrm{Nc}`w' \leqq 3$. Hence $\mathrm{Nc}`w' = 0$, that is, $w' = \Lambda$. Hence from (1), $\mathrm{cm}_\phi`u = \mathrm{cm}_\phi`v$. The converse is obvious.

*12·33. *Proposition.*—Assuming $(\lambda - \pi)\,\mathrm{H}p\,\phi$, if u and v are subclasses of O_ϕ, and v is not the null class, and $\mathrm{cm}_\phi`v$ is contained in, but is not identical with, $\mathrm{cm}_\phi`u$, then $\dim_\phi`v$ is less than $\dim_\phi`u$. In symbols,

$$\vdash .\therefore (\lambda - \pi)\,\mathrm{H}p\,\phi\,.\supset : u,\, v \in \mathrm{cls}`\mathrm{O}_\phi\,.\,\exists!v\,.\,\mathrm{cm}_\phi`v \subset \mathrm{cm}_\phi`u\,.\ \mathrm{cm}_\phi`v \neq \mathrm{cm}_\phi`u\,.\supset.\,\dim_\phi`v < \dim_\phi`u$$

Proof.—Cf. *12·21·23.

The following proposition should be compared with *12·12:—

*12·37. *Proposition.*—Assuming $(\lambda - \pi)\,\mathrm{H}p\,\phi$, if u is a subclass of O_ϕ, and is not the null class, there exists a subclass of u which is ϕ-prime and ϕ-equivalent to u. In symbols,

$$\vdash .\therefore (\lambda - \pi)\,\mathrm{H}p\,\phi\,.\supset : u \in \mathrm{cls}`\mathrm{O}_\phi\,.\,\exists!u\,.\supset.\,\exists!(\mathrm{prm}_\phi \cap \mathrm{cls}`u \cap \mathrm{equiv}_\phi`u)$$

Proof.—From *12·12·21, u is either of one, or of two, or of three ϕ-dimensions. If u is of one ϕ-dimension, the conclusion follows from *5·233 and *10·2 and *11·12. If u is of two ϕ-dimensions, then (cf. *5·235 and *10·2) any two members of it form a ϕ-prime class, and (cf. *12·21) the ϕ-dimension number of this class is not greater than two, and hence (cf. *6·25) it is two, and hence (cf. *12·23) this subclass

is ϕ-equivalent to u. If u is of three ϕ-dimensions, it must contain at least one subclass v consisting of two members, and, as before, v must be ϕ-prime. If v is of three ϕ-dimensions, then (cf. *12·23) u and v are ϕ-equivalent. If v is of two ϕ-dimensions, then there is a member of u, x say, which is not a member of $\mathrm{cm}_\phi{}'v$. Then, either $v \cup \iota'x$ is ϕ-prime and (cf. *12·23) ϕ-equivalent to u, or the class composed of x and some one (not necessarily any one) of the members of v is ϕ-prime and ϕ-equivalent to u.

The following proposition should be compared to *3·13 and *12·33:—

*12·41. *Proposition.*—Assuming $(\lambda - \pi)\ \mathrm{Hp}\ \phi$, if u is ϕ-axial, and v is a subclass of u, and both v and $(u - v)$ are not the null class, then $\dim_\phi{}'v$ is less than $\dim_\phi{}'u$. In symbols,

$$\vdash .\therefore (\lambda - \pi)\ \mathrm{Hp}\ \phi\ .\supset : u \in \mathrm{ax}_\phi\ .\ v \in \mathrm{cls}'u\ .\ \exists!v\ .\ \exists!(u - v)\ .\supset .\ \dim_\phi{}'v < \dim_\phi{}'u$$

Proof.—Cf. *3·13 and *4·21 and *11·21 and *12·21·23.

The following proposition should be compared to *5·23:—

*12·42. *Proposition.*—Assuming $(\lambda - \pi)\ \mathrm{Hp}\ \phi$, then, if u is a subclass of O_ϕ and is ϕ-axial, any subclass of u, not the null class, is ϕ-axial. In symbols,

$$\vdash .\therefore (\lambda - \pi)\ \mathrm{Hp}\ \phi\ .\supset : u \in \mathrm{ax}_\phi \cap \mathrm{cls}'\mathrm{O}_\phi\ .\ v \in \mathrm{cls}'u\ .\ \exists!v\ .\supset .\ v \in \mathrm{ax}_\phi$$

Proof.—From *6·26 we have $\mathrm{Nc}'u = \dim_\phi{}'u$; from *5·23 and *6·25 we have $\mathrm{Nc}'v \leqq \dim_\phi{}'v$. Hence (cf. *12·41), if v is not identical with u, we have

$$\mathrm{Nc}'v \leqq \dim_\phi{}'v < \mathrm{Nc}'u\ .\ .\ .\ .\ .\ .\ .\ .\ .\ (1)$$

Firstly, assume that v omits one member of u only. Then $\mathrm{Nc}'v + 1 = \mathrm{Nc}'u$. Hence, from (1), $\mathrm{Nc}'v = \dim_\phi{}'v$, and hence (cf. *3·21) v is ϕ-axial.

Secondly, if v omits two members of u, then it is a unit class, and (cf. *12·11) is ϕ-axial.

It is convenient to conclude this section (*12) with three theorems which are fundamental to the theory of ϕ-points and of ϕ-planes.

*12·51. *Proposition.*—Assuming $(\lambda - \pi)\ \mathrm{Hp}\ \phi$, if u is of two ϕ-dimensions, and x and y are members of $\mathrm{cm}_\phi{}'u$, then the class composed of x and y is ϕ-axial and is a subclass of O_ϕ. In symbols,

$$\vdash .\therefore (\lambda - \pi)\ \mathrm{Hp}\ \phi\ .\supset : \dim_\phi{}'u = 2\ .\ x, y \in \mathrm{cm}_\phi{}'u\ .\supset .\ \iota'x \cup \iota'y \in \mathrm{ax}_\phi \cap \mathrm{cls}'\mathrm{O}_\phi$$

Proof.—$\mathrm{cm}_\phi{}'u$ is contained in O_ϕ (cf. *4·21·27 and *10·1 and *11·21).

If x and y are identical, cf. *12·11. If x is distinct from y, then cf. *3·21 and *12·11·21·23.

*12·52. *Proposition.*—Assuming $(\lambda - \pi)\,\mathrm{H}p\,\phi$, if u has three members only, and is a self-ϕ-concurrence, and its ϕ-dimension number is three, then u is ϕ-axial and a subclass of O_ϕ. In symbols,

$$\vdash \therefore (\lambda - \pi)\,\mathrm{H}p\,\phi \,.\, \supset : u \in 3 \cap \mathrm{conc}_\phi \,.\, \mathrm{dim}_\phi = 3 \,.\, \supset \,.\, u \in \mathrm{ax}_\phi \cap \mathrm{cls}`\mathrm{O}_\phi$$

Proof.—If v is contained in u and possesses two members, then (cf. *3·31·32) v is ϕ-axial, and (cf. *12·23) is not ϕ-equivalent to u. Hence (cf. *5·231) u is ϕ-prime, and hence (cf. *3·22) is ϕ-axial, and also (cf. *11·21) is a subclass of O_ϕ.

*12·53. *Proposition.*—Assuming $(\lambda - \pi)\,\mathrm{H}p\,\phi$, if x, y, and z are three distinct entities forming a ϕ-axial class, then the common subclass of $\mathrm{cm}_\phi`(\iota`x \cup \iota`y)$ and $\mathrm{cm}_\phi`(\iota`x \cup \iota`z)$ is the unit class $\iota`x$. In symbols,

$$\vdash \therefore (\lambda - \pi)\,\mathrm{H}p\,\phi \,.\, \supset : \iota`x \cup \iota`y \cup \iota`z \in 3 \cap \mathrm{ax}_\phi \,.\, \supset \,.\, \mathrm{cm}_\phi`(\iota`x \cup \iota`y) \cap \mathrm{cm}_\phi`(\iota`x \cup \iota`z) = \iota`x$$

Proof.—Cf. *4·21·27 and *10·2 and *12·23·42.

*13. *On ϕ-Maximal Classes and Self-ϕ-Concurrences.*

*13·11. *Proposition.*—Assuming $(\lambda - \pi)\,\mathrm{H}p\,\phi$, if p is a ϕ-maximal class and a subclass of O_ϕ, and q is a subclass of p, not the null class, then q is a ϕ-maximal class. In symbols,

$$\vdash \therefore (\lambda - \pi)\,\mathrm{H}p\,\phi \,.\, \supset : p \in \mathrm{mx}_\phi \cap \mathrm{cls}`\mathrm{O}_\phi \,.\, q \in \mathrm{cls}`p \,.\, \exists!p \,.\, \supset \,.\, q \in \mathrm{mx}_\phi$$

Proof.—The class q must (cf. *10·3 and *12·21) be of one, or two, or three ϕ-dimensions. If the ϕ-dimension number of q is one or two, then (cf. *10·2 and *12·11·51) q is a ϕ-maximal class. If the ϕ-dimension number of q is three, then (cf. *12·23) q is ϕ-equivalent to p. Hence if v be a subclass of q, which is ϕ-prime and ϕ-equivalent to q, it is ϕ-equivalent to p, and hence (cf. *3·23) it is ϕ-axial. Hence (cf. *3·23 and *12·37) q is ϕ-maximal.

*13·31. *Proposition.*—Assuming $(\lambda - \pi)\,\mathrm{H}p\,\phi$, if u is a self-ϕ-concurrence and a subclass of O_ϕ, then u is a ϕ-maximal class. In symbols,

$$\vdash \therefore (\lambda - \pi)\,\mathrm{H}p\,\phi \,.\, \supset : u \in \mathrm{conc}_\phi \cap \mathrm{cls}`\mathrm{O}_\phi \,.\, \supset \,.\, u \in \mathrm{mx}_\phi$$

Proof.—There exists (cf. *12·37) a subclass (v) of u, which is ϕ-prime and ϕ-equivalent to u. If v is a unit class, then (cf. *10·2 and *12·11) v and u are identical, and u is of one ϕ-dimension and ϕ-maximal. If v is a couple, then (cf. *3·31·32) v is ϕ-axial, and (cf. *3·22·23) u is of two

ϕ-dimensions and is ϕ-maximal. If v is composed of three members, then u is of three ϕ-dimensions, and neither of the previous cases can hold. Hence again u is ϕ-maximal.

*13·32. *Proposition.*—Assuming $(\lambda - \pi)\,\mathrm{H}p\,\phi$, all subclasses of O_ϕ which are ϕ-maximal are self-ϕ-concurrent, and conversely. In symbols,

$$\vdash : (\lambda - \pi)\,\mathrm{H}p\,\phi \,.\supset.\, \mathrm{mx}_\phi \cap \mathrm{cls}`\mathrm{O}_\phi = \mathrm{conc}_\phi \cap \mathrm{cls}`\mathrm{O}_\phi$$

Proof.—Cf. *13·11·31.

*14. *On Points.*

*14·11. Assuming $(\lambda - \rho)\,\mathrm{H}p\,\phi$, every ϕ-point is a self-ϕ-concurrence and a subclass of O_ϕ. In symbols,

$$\vdash : (\lambda - \rho)\,\mathrm{H}p\,\phi \,.\supset.\, \mathrm{pnt}_\phi \subset \mathrm{conc}_\phi \cap \mathrm{cls}`\mathrm{O}_\phi$$

Proof.—Every ϕ-point (cf. *11·21) is a subclass of O_ϕ. Again let x and y be two distinct members of a ϕ-point P. Then (cf. *3·42) a, b, c exist such that $\iota`a \cup \iota`b \cup \iota`c$ is $\phi$-axial and of three dimensions, and $x$ and $y$ are each $\phi$-concurrent with each of $a$, $b$, and $c$. Hence (cf. *12·53) at least one pair of $a$, $b$, and $c$ exist (say $a$ and $b$) such that $\iota`x \cup \iota`a \cup \iota`b$ and $\iota`y \cup \iota`a \cup \iota`b$ are both three $\phi$-dimensional and self-$\phi$-concurrences. Hence (cf. *12·52) $\iota`x \cup \iota`a \cup \iota`b$ and $\iota`x \cup \iota`a \cup \iota`b$ are both $\phi$-axial. Hence (cf. *10·5 and *13·32) $\iota`x \cup \iota`y$ is ϕ-axial. Hence P is a self-ϕ-concurrence.

*14·12. *Proposition.*—Assuming $(\lambda - \rho)\,\mathrm{H}p\,\phi$, every ϕ-point is ϕ-maximal. In symbols,

$$\vdash : (\lambda - \rho)\,\mathrm{H}p\,\phi \,.\supset.\, \mathrm{pnt}_\phi \subset \mathrm{mx}_\phi$$

Proof.—Cf. *13·32 and *14·11.

*14·13. *Proposition.*—Assuming $(\lambda - \rho)\,\mathrm{H}p\,\phi$, if P is a ϕ-point, then P is the ϕ-concurrence of O_ϕ with P. In symbols,

$$\vdash .\therefore (\lambda - \rho)\,\mathrm{H}p\,\phi \,.\supset : \mathrm{P} \in \mathrm{pnt}_\phi \,.\supset.\, \mathrm{P} = \tilde{\mathrm{O}}_\phi`\mathrm{P}$$

Proof.—Cf. *3·42 and *8·21·22 and *14·11.

*14·14. *Proposition*—Assuming $(\lambda - \pi)\,\mathrm{H}p\,\phi$, if P is a ϕ-point, it possesses at least three members. In symbols,

$$\vdash .\therefore (\lambda - \pi)\,\mathrm{H}p\,\phi \,.\supset : \mathrm{P} \in \mathrm{pnt}_\phi \,.\supset.\, \mathrm{N}c`\mathrm{P} \geqq 3$$

Proof.—P possesses (cf. *3·42) every member of O_ϕ which is ϕ-con-

current with each of a certain ϕ-axial set of three members. Hence (cf. *12·42) P possesses this set of three members.

*14·21. *Proposition.*—Assuming $(\lambda - \rho)\ \mathrm{H}p\ \phi$, ϕ-points with more than one member in common are identical. In symbols,

$$\vdash .\therefore (\lambda - \rho)\ \mathrm{H}p\ \phi\ .\supset : \mathrm{P}, \mathrm{Q} \in \mathrm{pnt}_\phi\ .\ \mathrm{N}c`(\mathrm{P} \cap \mathrm{Q}) > 1\ .\supset .\ \mathrm{P} = \mathrm{Q}$$

Proof.—Let a and b be two distinct members of $\mathrm{P} \cap \mathrm{Q}$. Then (cf. *3·42 and *12·52 and *14·11) c and d exist, such that c is a member of P and d of Q, and $\iota`a \cup \iota`b \cup \iota`c$ and $\iota`a \cup \iota`b \cup \iota`d$ are both of them three ϕ-dimensional and ϕ-axial. Hence (cf. *10·5 and *13·32) d is a member of $\tilde{\mathrm{O}}_\phi`(\iota`a \cup \iota`b \cup \iota`c)$, and hence (cf. *3·42 and *14·11·13) d is a member of P. Thus P and Q are identical.

*16. *On ϕ-Planes.*

*16·11. *Proposition.*—Assuming $(\lambda - \pi)\ \mathrm{H}p\ \phi$, every ϕ-plane is ϕ-maximal, self-ϕ-concurrent, and a subclass of O_ϕ. In symbols,

$$\vdash : (\lambda - \pi)\ \mathrm{H}p\ \phi\ .\supset .\ \mathrm{ple}_\phi \subset \mathrm{mx}_\phi \cap \mathrm{conc}_\phi \cap \mathrm{cls}`\mathrm{O}_\phi$$

Proof.—Cf. *12·21·23·51.

*16·21. *Proposition.*—Assuming $(\lambda - \pi)\ \mathrm{H}p\ \phi$, ϕ-planes with more than one member in common are identical. In symbols,

$$\vdash .\therefore (\lambda - \pi)\ \mathrm{H}p\ \phi\ .\supset : p, q \in \mathrm{ple}_\phi\ .\ \mathrm{N}c`(p \cap q) > 1\ .\supset .\ p = q$$

Proof.—Cf. *12·23 and *16·11.

*16·31. *Proposition.*—Assuming $(\lambda - \pi)\ \mathrm{H}p\ \phi$, every self-$\phi$-concurrence is either ϕ-copunctual or ϕ-coplanar. In symbols,

$$\vdash .\therefore (\lambda - \pi)\ \mathrm{H}p\ \phi\ .\supset : u \in \mathrm{conc}_\phi\ .\supset .\ \mathrm{copnt}_\phi!u\ .\ \vee\ .\ \mathrm{cople}_\phi!u$$

Proof.—A proof is only required when u is of three ϕ-dimensions. Then a, b, c exist, such that they are three distinct members of u and are not a ϕ-coplanar class. Hence (cf. *12·52) they form a ϕ-axial class of three members. Hence (cf. *3·42) u is, in this case, ϕ-copunctual.

*16·32. *Proposition.*—Assuming $(\lambda - \rho)\ \mathrm{H}p\ \phi$, if p is a ϕ-plane, and P and Q are distinct ϕ-points, and p and P have common members, and also p and Q, then the member (if any) common to P and Q is a member of p. In symbols,

$$\vdash .\therefore (\lambda - \rho)\ \mathrm{H}p\ \phi\ .\supset : p \in \mathrm{ple}_\phi\ .\ \mathrm{P}, \mathrm{Q} \in \mathrm{pnt}_\phi\ .\ \mathrm{P} \neq \mathrm{Q}\ .\ \exists!(p \cap \mathrm{P})\ .\ \exists!(p \cap \mathrm{Q})\ .\supset .\ \mathrm{P} \cap \mathrm{Q} \subset p$$

Proof.—If $P \cap Q$ is the null class, then $P \cap Q$ is contained in p. If $P \cap Q$ is not null, let c be a member; also let a and b be, respectively, members of $p \cap P$ and of $p \cap Q$, which exist by hypothesis. (i) If c is identical with a or b, then (cf. *14·21) $P \cap Q$ is contained in p. Again (ii) if c is not identical with a or b, then (cf. *14·11 and *16·11) a, b and c form a self-ϕ-concurrence. Hence (cf. *16·31) this class is either ϕ-copunctual or ϕ-coplanar. If the class is ϕ-copunctual, then (cf. *14·21) P and Q are identical. Hence it is ϕ-coplanar, and hence (cf. *16·21) c is a member of p.

*16·33. *Proposition.*—Assuming $(\lambda - \rho)\, \mathrm{H}p\, \phi$, if P is a ϕ-point and p and q are distinct ϕ-planes, and P and p have common members, and so, also, have P and q, then the member (if any) common to p and q is a member of P. In symbols,

$$\vdash \therefore (\lambda - \rho)\, \mathrm{H}p\, \phi \,.\supset : \mathrm{P} \in \mathrm{pnt}_\phi \,.\, p, q \in \mathrm{ple}_\phi \,.\, p \neq q \,.\, \exists!(\mathrm{P} \cap p) \,.\, \exists!(\mathrm{P} \cap q) \,.\supset.\, p \cap q \subset \mathrm{P}$$

Proof.—The proof is in all respects similar to that of *16·32.

*16·42. *Proposition.*—Assuming $(\lambda - \rho)\, \mathrm{H}p\, \phi$, if p is a ϕ-plane and is not ϕ-copunctual, then p is the ϕ-concurrence of O_ϕ with p. In symbols,

$$\vdash \therefore (\lambda - \rho)\, \mathrm{H}p\, \phi \,.\supset : p \in \mathrm{ple}_\phi \,.\backsim \mathrm{copnt}_\phi!p \,.\supset.\, p = \tilde{\mathrm{O}}_\phi{}'p$$

Proof.—From *8·21 and *16·11 we have

$$p \subset \tilde{\mathrm{O}}_\phi{}'p \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

Let x be any member of the ϕ-concurrence of O_ϕ with p. Hence (cf. *16·11) $p \cup \iota'x$ is a self-ϕ-concurrence. Hence (cf. 16·31) $p \cup \iota'x$ is either ϕ-copunctual or ϕ-coplanar. But on the first alternative p is ϕ-copunctual. Hence $p \cup \iota'x$ is ϕ-coplanar. Hence x is a member of p. Hence from (1) the proposition follows.

Note.—In Concept V the hypothesis of *16·42, that a ϕ-plane is not copunctual, is verified (cf. *28·11), where ϕ represents 'homaloty,' and the axioms of that concept are assumed.

Summary of the Complete Development of this Subject.—By the use of further axioms the whole theory of projective geometry, apart from 'order' and apart from Fano's axiom* respecting the distinction of harmonic conjugates, can be proved for ϕ-points and the associated

* Cf. Pieri, *loc. cit.*

geometrical entities. Then Fano's axiom can be added, and the theory of order and continuity can be introduced, as in Pieri's memoir (*loc. cit.*). In the sequel a somewhat different line of development is adopted, suitable for the special ideas of Concept V.

(ii) Concept V

This concept is linear and monistic. It makes use both of the theory of interpoints and of the theory of dimensions. The points are classes of objective reals, and disintegrate from instant to instant. The corpuscles are capable of various and complicated structures, and are thus well fitted to bear the weight of modern physical ideas. The concept is Leibnizian, and only requires one extraneous relation for the same purposes as that of Concept III.

The essential relation is the pentadic relation $R^{\cdot}(abcdt)$, as explained at the commencement of Part III. The four first terms, namely, *a*, *b*, *c*, *d*, are objective reals and are mutually distinct, the fifth term is an instant of time.

The relation $R^{\cdot}(abcdt)$ can be read, *a intersects b, c, d in the order bcd at the instant t*. In this concept *copunctual* objective reals do *not* necessarily *intersect*, though two intersecting objective reals are necessarily copunctual. The relation of *intersection* is not to be limited in properties by the mere geometrical suggestion of its technical name.

Since points are defined by the aid of the theory of dimensions, it follows (cf. note to *3·42) that the geometry cannot be of less than three dimensions. Hence in this concept geometry of three dimensions occupies a position of unique simplicity.

The points at infinity, here called *cogredient points*, are points in exactly the same sense as the other points. They are defined by a property not hitherto taken as fundamental. The properties of cogredient points play an essential part in the construction of a relation which assigns an *order* to the points on any straight line.

*20. *Definitions.*

*20·11. *Definition.*—An objective real *p* is *doubly secant* with a class *u* at an instant *t* if there exist two objective reals, members of *u* (*x* and *y*, say), which are both intersected by *p* at the instant *t*, and are such that there exists no interpoint on *p* of which *x* and *y* are both members. The symbol $(\widetilde{uu})_{Rt}!p$ will denote that *p* is doubly secant with *u* at the instant *t*. The symbolic definition is

$$(\widetilde{uu})_{\mathrm{R}t}!p \;.=: (\exists x, y)\,.\, x \neq y\,.\, x, y \in u \cap \mathrm{R}i(p;;;t)\,.\backsim(\exists v)\,.\; v \in \mathrm{R}i(p???t)\,.\, x, y \in v \qquad \mathrm{Df}$$

*20·12. *Definition.*—A class u is *homalous* at an instant t, *either* when a necessary and sufficient condition, that x should be a member of u, is that x should be doubly secant with u, *or* when u is a unit class contained in $\mathrm{R}i(;;;;t)$. The symbol $\mu_{\mathrm{R}t}!u$ will denote that u has the property of homaloty at the instant t. The symbolic definition is

$$\mu_{\mathrm{R}t}!u \;.=\therefore x \in u\,.\,\Xi_x\,.\,(\widetilde{uu})_{\mathrm{R}t}!x : \vee : u \in 1 \cap \mathrm{cls}`\mathrm{R}i(;;;;t) \qquad \mathrm{Df}$$

This property ($\mu_{\mathrm{R}t}$) of homaloty will now be taken as the special value of ϕ, to which the theory of dimensions will be applied. The common $\mu_{\mathrm{R}t}$-subregion for u is denoted, according to the definition of *3·12, by $\mathrm{cm}_{\mu_{\mathrm{R}t}}`u$. But a suffix to a suffix will be avoided by using the simpler symbol $\mathrm{cm}_{\mathrm{R}t}`u$, and similarly for the other entities defined in *3. Thus the following symbols are also defined, namely,

$$\mathrm{O}_{\mathrm{R}t},\quad \mathrm{equiv}_{\mathrm{R}t}`u,\quad \mathrm{prm}_{\mathrm{R}t},\quad \mathrm{dim}_{\mathrm{R}t},\quad \mathrm{ax}_{\mathrm{R}t},\quad \mathrm{mx}_{\mathrm{R}t},\quad \tilde{u}_{\mathrm{R}t}`v,\quad \mathrm{conc}_{\mathrm{R}t},$$
$$\mathrm{ple}_{\mathrm{R}t},\quad \mathrm{pnt}_{\mathrm{R}t},\quad \mathrm{cople}_{\mathrm{R}t}!u,\quad \mathrm{copnt}_{\mathrm{R}t}!u.$$

With regard to the nomenclature, the term 'ϕ-equivalence' should be particularized into 'homaloty-equivalence,' and 'ϕ-prime' into 'homaloty-prime,' and so on. But, except where confusion is likely to occur, the term 'homaloty' will be dropped; and the terms 'equivalence,' 'prime,' 'dimensions,' 'axial,' 'maximal,' 'concurrence of u with v,' 'self-concurrence,' 'plane,' 'point,' 'coplanar,' 'copunctual' will be used in the senses defined in *3, with ϕ particularized into homaloty.

Elucidatory Note.—This definition of *homaloty* should be compared with the definition of the *flatness* of a class of punctual lines which has been used in the elucidatory notes of *3. Thus a class of punctual lines is flat, *either* when it is a unit class whose single member is a straight line, *or* when it is a necessary and sufficient condition of a straight line x being a member of it, that x should meet two members of the class in points which are not their point of meeting (if they have a point of meeting). Owing to the fact that 'intersection' (as used here) is wider in intension and narrower in extension than the idea of the 'meeting' of two punctual lines, two punctual lines may 'meet' without the corresponding objective reals 'intersecting.' The result is that homaloty and flatness have some different properties, for example, cf. *21·21.

*20·21. *Definition.*—The *punctual associate* of a class u is the class of

those points which have a member in common with u. The punctual associate of u is denoted by $\mathrm{ass}_{\mathrm{R}t}$'$u$. The definition in symbols is

$$\mathrm{ass}_{\mathrm{R}t}\text{`}u = \dot{\mathrm{P}}\{\mathrm{P} \in \mathrm{pnt}_{\mathrm{R}t} \,.\, \exists!(\mathrm{P} \cap u)\} \qquad \text{Df}$$

Note.—The punctual associate of the class ι'a, *where a is an objective real*, will be called the punctual associate of a. Its symbol is $\mathrm{ass}_{\mathrm{R}t}$'$\iota$'$a$.

*20·22. *Definition.*—A *punctual line* is a class of points such that there exist two planes, p and q, which are distinct and are such that the class of points is the common subclass of the punctual associates of p and q. The class of punctual lines at any instant t is denoted by $\mathrm{lin}_{\mathrm{R}t}$. The symbolic definition is

$$\mathrm{lin}_{\mathrm{R}t} = \dot{m}\{(\exists p, q) \,.\, p, q \in \mathrm{ple}_{\mathrm{R}t} \,.\, p \neq q \,.\, m = \mathrm{ass}_{\mathrm{R}t}\text{`}p \cap \mathrm{ass}_{\mathrm{R}t}\text{`}q\} \qquad \text{Df}$$

Note.—Those punctual lines which are not 'lines at infinity' (to be explained later) will be proved as the result of the axioms to be the punctual associates of the various objective reals.

*20·23. *Definition.*—The point, if there is one and one only, which contains a class u is called the *dominant point of u*. The dominant point of u is denoted by $u_{\mathrm{R}t}$. The symbolic definition is

$$u_{\mathrm{R}t} = (\imath p)\ \{p \in \mathrm{pnt}_{\mathrm{R}t} \,.\, u \in \mathrm{cls}\text{`}p\} \qquad \text{Df}$$

Note.—The idea of a dominant point obtains its importance from the fact that, according to the axioms given below, each interpoint is contained in one and only one point.

*20·231. *Definition.*—The *nonsecant part of u* is that subclass of u of which no member is a member of any interpoint which is a subclass of u. The nonsecant part of u is denoted by $\mathrm{nsc}_{\mathrm{R}t}$'$u$. The symbolic definition is

$$\mathrm{nsc}_{\mathrm{R}t}\text{`}u = \dot{x}\{x \in u \,.\, \backsim(\exists v) \,.\, v \in \mathrm{intpnt}_{\mathrm{R}t} \cap \mathrm{cls}\text{`}u \,.\, x \in v\} \qquad \text{Df}$$

Note.—This definition takes its importance from the fact that (assuming the subsequent axioms) a point in general consists of a nonsecant part and of a part made up of interpoints contained in it. Either the interpoints or the nonsecant part may be wholly absent.

*20·232. *Definition.*—A class of points is called a *Figure*.

*20·233. *Definition.*—A point, which is a member of a figure, will be said to *lie in* that figure.

*20·234. *Definition.*—A point, which lies in the punctual associate of a class of objective reals, will be said to *be on*, or *upon*, that class.

*20·235. *Definition.*—A punctual line is said to *join* two points if both the points lie in it.

*20·236. *Definition.*—Two punctual lines, which possess a common point, will be said to *meet at* that point. Similarly, any two classes of points will be said to *meet in* their common subclass, and this subclass will be called their *meeting*.

*20·24. *Definition.*—A class of points is called *collinear* if there exist a punctual line in which they all lie. The symbol $\mathrm{coll}_{\mathrm{R}_t}!u$ will denote that u is a class of collinear points at the instant t. The symbol definition is

$$\mathrm{coll}_{\mathrm{R}_t}!u \;.\; = \;.\; (\exists m) \;.\; m \in \mathrm{lin}_{\mathrm{R}_t} \;.\; u \in \mathrm{cls}`m \qquad \mathrm{Df}$$

*20·31. *Definition.*—Two figures are *in perspective* if (i) they have a one-one correspondence to each other, (ii) the joint figure formed by the two figures combined is not collinear, and (iii) there exists a point (the centre of perspective) which lies in every punctual line joining two *distinct* corresponding points. The statement that u and v are in perspective with each other at the instant t, and that S is the requisite one-one correspondence, will be denoted by $u(\mathrm{S\ persp})_{\mathrm{R}_t}v$. The symbol definition is

$$\begin{aligned} u(\mathrm{S\ persp})_{\mathrm{R}_t}v \;.\; = \;:\; & u,\, v \in \mathrm{cls}`\mathrm{pnt}_{\mathrm{R}_t} \;.\; \backsim \mathrm{coll}_{\mathrm{R}_t}!(u \cup v) \;.\; \mathrm{S} \in 1 \longrightarrow 1 \;. \\ & u = \mathrm{S}`(;\cdot) \;.\; v = \mathrm{S}`(\cdot;) \;:\; (\exists \mathrm{V}) \;:\; m \in \mathrm{lin}_{\mathrm{R}_t} \;.\; \mathrm{S}`(\mathrm{AA}') \;.\; \mathrm{A} \neq \mathrm{A}' \;. \\ & \mathrm{A},\, \mathrm{A}' \in m \;.\; \supset_{m,\,\mathrm{A},\,\mathrm{A}'} \;.\; \mathrm{V} \in m \end{aligned} \qquad \mathrm{Df}$$

*20·32. *Definition.*—The symbol $[\mathrm{AB}]\ \mathrm{persp}_{\mathrm{R}_t}\ [\mathrm{A}'\mathrm{B}']$ denotes that A, B, A′, B′ are points, and that the figure formed by A and B is in perspective with the figure formed by A′ and B′, and that the one-one correspondence of the perspective is of A to A′ and of B to B′. Also $[\mathrm{ABC}]\ \mathrm{persp}_{\mathrm{R}_t}\ [\mathrm{A}'\mathrm{B}'\mathrm{C}']$ has a similar meaning, and so on. In symbols,

$$\begin{aligned} [\mathrm{AB}]\ \mathrm{persp}_{\mathrm{R}_t}\ [\mathrm{A}'\mathrm{B}'] \;.\; = \;.\; & (\exists \mathrm{S}) \;.\; (\iota`\mathrm{A} \cup \iota`\mathrm{B})\ (\mathrm{S\ persp})_{\mathrm{R}_t}\ (\iota`\mathrm{A}' \cup \iota`\mathrm{B}') \;. \\ & \mathrm{S}`(\mathrm{AA}') \;.\; \mathrm{S}`(\mathrm{BB}') \end{aligned} \qquad \mathrm{Df}$$

$$\begin{aligned} [\mathrm{ABC}]\ \mathrm{persp}_{\mathrm{R}_t}\ [\mathrm{A}'\mathrm{B}'\mathrm{C}'] \;.\; = \;.\; & (\exists \mathrm{S}) \;.\; (\iota`\mathrm{A} \cup \iota`\mathrm{B} \cup \iota`\mathrm{C})\ (\mathrm{S\ persp})_{\mathrm{R}_t} \\ & (\iota`\mathrm{A}' \cup \iota`\mathrm{B}' \cup \iota`\mathrm{C}') \;.\; \mathrm{S}`(\mathrm{AA}') \;.\; \mathrm{S}`(\mathrm{BB}') \;.\; \mathrm{S}`(\mathrm{CC}') \end{aligned} \qquad \mathrm{Df}$$

*20·33. *Definition.*—The symbol $u\ \mathrm{persp}_{\mathrm{R}_t}\ v$ denotes that there exists a one-one relation S such that, at the instant t, u is in perspective with v and S is the requisite one-one correspondence. In symbols,

$$u\ \mathrm{persp}_{\mathrm{R}_t}\ v \;.\; = \;.\; (\exists \mathrm{S}) \;.\; u\ (\mathrm{S\ persp})_{\mathrm{R}_t}\ v \qquad \mathrm{Df}$$

*20·41. *Definition.*—Two objective reals, a and c, are called *cogredient* at an instant t when (1) if u, v, w are three interpoints on a, and u', v', w' are three interpoints on c, and the dominant points $u_{\mathrm{R}t}$, $v_{\mathrm{R}t}$, $w_{\mathrm{R}t}$ are a trio of points in perspective with the trio of dominant points $u'_{\mathrm{R}t}$, $v'_{\mathrm{R}t}$, $w'_{\mathrm{R}t}$, then the interpoint relation (R_{in}), if it arranges either trio of interpoints in an interpoint order, arranges both trios of interpoints in the same interpoint order (i.e., either uvw and $u'v'w'$, or vwu and $v'w'u'$, or so on), and (2) there exist three interpoints u, v, w on a in the interpoint order uvw, and three interpoints u', v', w' on c such that $u_{\mathrm{R}t}$, $v_{\mathrm{R}t}$, $w_{\mathrm{R}t}$ are in perspective with $u'_{\mathrm{R}t}$, $v'_{\mathrm{R}t}$, $w'_{\mathrm{R}t}$. The symbol $\mathrm{cogrd}_{\mathrm{R}t}$‘$a$ denotes the class of objective reals cogredient with α. The symbolic definition is

$$\mathrm{cogrd}_{\mathrm{R}t}\text{‘}a =$$
$$\dot{x}\{(u, v, w, u', v', w') : u, v, w \in \mathrm{R}^{\mathrm{i}}(a???t) \,.\, u', v', w' \in \mathrm{R}^{\mathrm{i}}(x???t) \,.$$
$$[u_{\mathrm{R}t}v_{\mathrm{R}t}w_{\mathrm{R}t}]\ \mathrm{persp}_{\mathrm{R}t}\ [u'_{\mathrm{R}t}v'_{\mathrm{R}t}w'_{\mathrm{R}t}] \,.\, \supset \,.\, \mathrm{R}_{\mathrm{in}}{}^{\mathrm{i}}(uvwt) \equiv \mathrm{R}_{\mathrm{in}}{}^{\mathrm{i}}(u'v'w't) :$$
$$(\exists\, u, v, w, u', v', w') \,.\, u, v, w \in \mathrm{R}^{\mathrm{i}}(a???t) \,.\, u', v', w' \in \mathrm{R}^{\mathrm{i}}(x???t) \,.$$
$$\mathrm{R}_{\mathrm{in}}{}^{\mathrm{i}}(uvwt) \,.\, [u_{\mathrm{R}t}v_{\mathrm{R}t}w_{\mathrm{R}t}]\ \mathrm{persp}_{\mathrm{R}t}\ [u'_{\mathrm{R}t}v'_{\mathrm{R}t}w'_{\mathrm{R}t}]\} \qquad \mathrm{Df}$$

Note.—The class $\mathrm{cogrd}_{\mathrm{R}t}$‘$a$ does not include a itself (cf. *27·43). It will be noticed that universal preservation of order by ranges in perspective on a pair of lines is a characteristic of a pair of parallel lines in Euclidean space, and of nonsecant lines in hyperbolic space. The choice of this property for the definition of parallelism (or nonsecancy) arises from the facts that (1) any two coplanar objective reals are copunctual (according to the subsequent axioms), so that the property of nonsecancy (in its ordinary acceptation) is not available, (2) we do not wish to make 'cogredience' synonymous with 'nonintersection' (using 'intersection' in the special sense here defined), as this would impose an unnecessary limitation on the concept. The idea of cogredience is an essential element in the definition of a relation which, with the aid of axioms, distributes the points in any punctual line into an order.

*20·42. *Definition.*—A *Cogredient Point* is the class of objective reals cogredient with some objective real a, together with a itself. The symbol $\infty_{\mathrm{R}t}$ denotes the class of cogredient points at the instant t. The definition in symbols is

$$\infty_{\mathrm{R}t} = \dot{u}\{(\exists a) \,.\, a \in \mathrm{O}_{\mathrm{R}t} \,.\, u = \iota\text{‘}a \cup \mathrm{cogrd}_{\mathrm{R}t}\text{‘}a\} \qquad \mathrm{Df}$$

Note.—In the case of Euclidean geometry, which is the only case considered here, each cogredient point is a point according to the

definition of *3·42. The present definition would be very inconvenient, unless this were the case. The symbol ∞_{R_t} is reminiscent of the fact that the cogredient points are the points at infinity.

*20·51. *Definition.*—The *Point-Ordering Relation* is a tetradic relation holding between three points and an instant of time. Its symbol is R_{pn}, and R_{pn}‘(ABCt) is defined to mean that, at the instant t, (1) A, B, C are non-cogredient points upon the same objective real, a say, and (2) there exist an objective real x and three interpoints u, v, w on x such that (i) x is cogredient with a, and (ii) u, v, w are in the interpoint order uvw, and (iii) A, B, C are in perspective with the dominant points u_{R_t}, v_{R_t}, w_{R_t}. The definition in symbols is

$$R_{pn}\text{‘}(ABCt) \;.\; = \;.\; A, B, C \in \mathrm{pnt}_{R_t} - \infty_{R_t} \;.\; (\exists a, x, u, v, w) \;.$$
$$a \in A \cap B \cap C \;.\; x \in \mathrm{cogrd}_{R_t}\text{‘}a \;.\; u, v, w \in R\text{‘}(x???t) \;.$$
$$R_{in}\text{‘}(uvwt) \;.\; [ABC]\; \mathrm{persp}_{R_t}\, [u_{R_t} v_{R_t} w_{R_t}] \qquad \text{Df}$$

Note.—Since (cf. *27·43) x in the above definition is distinct from a, three collinear (i.e., on a) points, A, B, C, cannot directly take their point-order from three interpoints which they themselves may severally contain (cf. however *21·51). The point-order of A, B, and C must arise from the order communicated (in a sense) to a copunctual pencil of three punctual lines by three interpoints contained respectively in points in these lines, and all three interpoints possessing an objective real (x) in common. The punctual lines of this pencil must possess A, B, and C respectively. This intervention of a pencil for the communication of point-order is necessary for the comparison of the orders of different ranges. If the apparently simpler plan is adopted, inextricable difficulties seem to arise. Also it will be remembered that not every point will necessarily contain an interpoint.

*20·61. *Definition.*—A *Punctual Plane* is a figure which is *either* the punctual associate of some plane, *or* is the class ∞_{R_t}. The class of punctual planes is denoted by pple_{R_t}. The definition in symbols is

$$\mathrm{pple}_{R_t} = \mathrm{ass}_{R_t}\text{“}\mathrm{ple}_{R_t} \cup \iota\text{‘}\, \infty_{R_t} \qquad \text{Df}$$

Note.—This definition is only convenient for Euclidean geometry.

*20·72. *Definition.*—A figure is called *Punctually Coplanar* if there is a punctual plane containing it. The symbol $\mathrm{copple}_{R_t}!u$ will denote that u is a punctually coplanar figure at the instant t. In symbols,

$$\mathrm{copple}_{R_t}!u \;.\; = \;.\; (\exists p) \;.\; p \in \mathrm{pple}_{R_t} \;.\; u \in \mathrm{cls}\text{‘}p \qquad \text{Df}$$

Note.—This definition should be compared with that of $\text{cople}_{R_t}!u$ in *3·43.

*21. *General Deductions.*

*21·01. *Proposition.*—All the general deductions in the theory of dimensions, namely, *4 to *8, hold.

The following propositions, dependent on the special definition of homaloty, also hold:—

*21·11. *Proposition.*—O_{R_t} is the class $R^i(;;;;t)$. In symbols,

$$\vdash . O_{R_t} = R^i(;;;;t)$$

Proof.—Cf. *20·12.

Note.—If t is not an instant of time, the classes O_{R_t} and $R^i(;;;;t)$ are both the null class, and are thus identical. Accordingly the hypothesis, $t \in T$, is not required in this proposition. A similar explanation of the absence of the hypothesis, $t \in T$, holds for many other propositions.

*21·21. *Proposition.*—An objective real, which is doubly secant with the common subregion for u, is a member of the common subregion for u. In symbols,

$$\vdash : w = \text{cm}_{R_t}`u . (\breve{w}w)_{R_t}!x . \supset . x \in \text{cm}_{R_t}`u$$

Proof.—Cf. *3·12 and *20·11.

Note.—The converse is not in general true, namely, that, if u is a class of objective reals, and x is a member of $\text{cm}_{R_t}`u$, then $x$ is doubly secant with $\text{cm}_{R_t}`u$. Nor does this converse follow from subsequent axioms. In the absence of this converse proposition the properties of homaloty differ from those of 'flatness' for classes of punctual lines. For if u is a class of punctual lines, and ϕ stands for the property of flatness, then $\text{cm}_{\phi}`u$ is flat.

*21·31. *Proposition.*—The proposition $\mu \text{ H}p \phi$ is true when μ_{R_t} is substituted for ϕ. In symbols,

$$\vdash . \mu \text{ H}p \mu_{R_t}$$

Proof.—Cf. *10·2 and *20·12.

*21·41. *Proposition.*—If a is an objective real cogredient with c, then c is cogredient with a. In symbols,

$$\vdash : a \in \text{cogrd}_{R_t}`a . \equiv . c \in \text{cogrd}_{R_t}`a$$

Proof.—Cf. *20·41.

*21·51. *Proposition.*—If u, v, w be three interpoints, possessing the same objective real, and with dominant points u_{Rt}, v_{Rt}, w_{Rt}, then $R_{pn}{}'(u_{Rt}v_{Rt}w_{Rt}t)$ implies $R_{in}{}'(uvwt)$. In symbols,

$$\vdash .\therefore u, v, w \in R'(a???t) . \supset : R_{pn}{}'(u_{Rt}v_{Rt}w_{Rt}t) . \supset . R_{in}{}'(uvwt)$$

Proof.—By definition (cf. *20·51) $R_{pn}{}'(u_{Rt}v_{Rt}w_{Rt}t)$ implies (1) the existence of an objective real x, cogredient with a, and also of three interpoints, u', v', w', all possessing x, and (2) that $R_{in}{}'(u'v'w't)$, and (3) that u', v', w' are contained in dominant points u'_{Rt}, v'_{Rt}, w'_{Rt} in perspective with u_{Rt}, v_{Rt}, w_{Rt}. Hence by the definition of cogredience (cf. *20·41) also $R_{in}{}'(uvwt)$ holds.

*22. *The Axioms.*—Just as in Concept III, the axiom of persistence (cf. *22·1) does not enter into the geometrical reasoning, but it is essential to the physical side of the concept.

*22·1. I Hp R is the statement that, *if t be an instant of time,* O *is contained in* O_{Rt}. In symbols,

$$\text{I H}p\ \text{R} . = : t \in \text{T} . \supset_t . \text{O} \subset O_{Rt} \qquad \text{Df}$$

The next four axioms, viz. (II–V) Hp R, are the axioms of order. They have already been explained in *1·51·52·53·54.

*22·21. II Hp R $= \alpha$ Hp R Df

*22·22. III Hp R $= \beta$ Hp R Df

*22·23. IV Hp R $= \gamma$ Hp R Df

*22·24. V Hp R $= \delta$ Hp R Df

The next three axioms, viz. (VI–VIII) Hp R, are the axioms establishing the relation of interpoints to points. Intpnt Hp R has been defined in *1·41.

*22·31. VI Hp R = intpnt Hp R Df

*22·32. VII Hp R is the statement that, *if u is an interpoint, there exists a point containing u.* In symbols,

$$\text{VII H}p\ \text{R} . = : (t, u) : u \in \text{intpnt}_{Rt} . \supset . (\exists p) . p \in \text{pnt}_{Rt} . u \subset p \qquad \text{Df}$$

*22·33. VIII Hp R is the statement that, *if p be a point, and u and v be two distinct interpoints contained in p, then u and v possess no common member.* In symbols,

$$\text{VIII H}p\ \text{R} . = : (p, u, v, t) : p \in \text{pnt}_{Rt} . u, v \in \text{intpnt}_{Rt} \cap \text{cls}'p . u \neq v . \supset . u \cap v = \Lambda \qquad \text{Df}$$

The next set of three axioms, viz. (IX–XI) H*p* R, supplies the missing hypotheses requisite to make homaloty a 'geometrical property,' as defined in *10.

*22·41. IX H*p* R is the statement that, *if t is an instant of time, ν H*p* μ_{Rt} is true.* In symbols,

$$\text{IX H}p\ \text{R} . = : t \in \text{T} . \supset_t . \nu\ \text{H}p\ \mu_{Rt} \quad \text{Df (cf. *10·3)}$$

*22·42. X H*p* R is the statement that, *if t is an instant of time, π H*p* μ_{Rt} is true.* In symbols,

$$\text{X H}p\ \text{R} . = : t \in \text{T} . \supset_t . \pi\ \text{H}p\ \mu_{Rt} \quad \text{Df (cf. *10·4)}$$

*22·43. XI H*p* R is the statement that, *if t is an instant of time, ρ H*p* μ_{Rt} is true.* In symbols,

$$\text{XI H}p\ \text{R} . = : t \in \text{T} . \supset_t . \rho\ \text{H}p\ \mu_{Rt} \quad \text{Df (cf. *10·5)}$$

*22·51. XII H*p* R is the statement that, *if p and q are distinct planes, and there exists a point, not a cogredient point, which is a member of the punctual associates of both planes, then p and q possess a common member.* In symbols,

$$\text{XII H}p\ \text{R} . = : p, q \in \text{ple}_{Rt} . p \neq q . \exists!\{(\text{ass}_{Rt}`p \cap \text{ass}_{Rt}`q) = \infty_{Rt}\} . \supset_{p,q,t} . \exists!(p \cap q) \quad \text{Df}$$

The next axiom, XIII H*p* R, is the 'Euclidean' axiom.

*22·61. XIII H*p* R is the statement that *the cogredient points are points.* In symbols,

$$\text{XIII H}p\ \text{R} . = . \infty_{Rt} \subset \text{pnt}_{Rt} \quad \text{Df}$$

The next three axioms, namely (XIV–XVI) H*p* R, establish the theory of the order of points as determined by the point-ordering relation (cf. *20·51). Incidentally some existence theorems can be deduced from them, which would else have to be provided for elsewhere.

*22·71. XIV H*p* R is the statement that, *if* A *and* B *are two distinct non-cogredient points, then there exists at least one point* C *such that* A, B, C *are in the point-order* ABC *at the instant considered.* In symbols,

$$\text{XIV H}p\ \text{R} . = : (\text{A}, \text{B}, t) : \text{A}, \text{B} \in \text{pnt}_{Rt} = \infty_{Rt} . \supset . \exists!\text{R}_{\text{pn}}`(\text{AB};t) \quad \text{Df}$$

*22·72. XV H*p* R is the statement that, *if* A, B, C *are three distinct non-cogredient points, on the same objective real, then at the instant considered one of the point-orders* ABC, *or* BCA, *or* CAB *holds.* In symbols,

$$\text{XV } Hp\,R\,.= .\therefore (A, B, C, t) .\therefore A, B, C \in \text{pnt}_{R_t} - \infty_{R_t} . \exists ! (A \cap B \cap C) .$$
$$A \neq B . B \neq C . C \neq A . \supset : R_{pn}{}^{\iota}(ABC t) . \vee . R_{pn}{}^{\iota}(BCA t) . \vee .$$
$$R_{pn}{}^{\iota}(CAB t) \quad \text{Df}$$

The next axiom, XVI H*p* R, is the well-known 'transversal' axiom.

*22·73. XVI H*p* R is the statement that, *if at the instant t the points* B, C, D *are in the point-order* BCD, *and the points* C, E, A *are in the point-order* CEA, *and the points* A, B, C *are not collinear, and* F *lies in the punctual associates both of* $A \cap B$ *and of* $D \cap E$, *then the points* A, F, B *are in the point-order* AFB. In symbols,

$$\text{XVI } Hp\,R\,. = : (A, B, C, D, E, F, t) : R_{pn}{}^{\iota}(BCD t) . R_{pn}{}^{\iota}(CEA t) .$$
$$A \cap B \cap C = \Lambda . F \in \text{ass}_{R_t}{}^{\iota}(A \cap B) \cap \text{ass}_{R_t}{}^{\iota}(D \cap E) . \supset . R_{pn}{}^{\iota}(AFB t) \quad \text{Df}$$

*22·74. As XVII H*p* R, an axiom of continuity will be wanted.

Note.—The above axioms are all axioms of *geometry*, in the sense of 'geometry' as defined in the sense definition of it given in Part I (i). But geometry in this Concept V includes more than does geometry in Concept I. For in Concept I geometry has only to do with points, punctual lines, and punctual planes; but in Concept V geometry has, in addition, to consider the relation of the objective reals (which are all 'linear') and of interpoints to the above entities. In this respect, geometry in Concept V merges into physics more than does geometry in Concept I. Thus the excess of the number of axioms in Concept V over the number in Concept I arises from the fact that there is a larger field to be covered. Also, I H*p* R is not required in the geometrical reasoning.

*25. *Preliminary Propositions.*

*25·11. *Proposition.*—Assuming (II–VI) H*p* R, all the propositions of the theory of interpoints (cf. *1) hold of the interpoints of this Concept.

*25·12. *Proposition.*—Assuming (II–VI) H*p* R, if *t* be an instant of time, then O_{R_t} possesses at least *four* members. In symbols,

$$\vdash .\therefore \text{IX } Hp\,R\,. \supset : t \in T . \supset . Nc{}^{\iota}O_{R_t} \geqq 4$$

Proof.—Cf. *1·61·71·72·73 and *21·11 and *25·11.

*25·13. *Proposition.*—Assuming (II–VI) H*p* R, if *t* be an instant of time, then O_{R_t} is homalous. In symbols,

$$\vdash .\therefore (\text{II–VI})\ Hp\,R\,. \supset : t \in T . \supset . \mu_{R_t}{}^{\iota}O_{R_t}$$

Proof.—From *1·65 and *21·11, O_{R_t} is identical with $R^{\iota}(;\cdots t)$.

Hence (cf. *1·31·61·62) every member of O_{Rt} is doubly secant with O_{Rt}. Again (cf. *21·11), every objective real which is doubly secant with O_{Rt} is a member of it.

*25·14. *Proposition.*—Assuming (II–VI, IX–XI) H*p* R, if t be an instant of time, then all the special deductions of the theory of dimensions, namely *11 to *16, hold respecting homaloty, that is, with μ_{Rt} substituted for ϕ.

Proof.—Cf. *21·31 and *22·41·42·43 and *25·13.

*25·21. *Proposition.*—Assuming I H*p* R, if t is an instant of time, then $O = O_{Rt}$. In symbols,

$$\vdash .\therefore \text{I H}p\ \text{R} . \supset : t \in \text{T} . \supset . \text{O} = \text{O}_{Rt}.$$

Proof.—Cf. *21·11 and *22·1.

Note.—The above theorem is not used in any geometrical reasoning.

*25·31. *Proposition.*—Assuming (II–VIII) H*p* R, if a be a member of O_{Rt}, then the number of points on a is at least three. In symbols,

$$\vdash .\therefore \text{(II–VIII) H}p\ \text{R} . \supset : a \in \text{O}_{Rt} . \supset . \text{Nc`ass}_{Rt}\text{`}\iota\text{`}a \geqq 3$$

Proof.—Cf. *1·72 and *21·11 and *22·32·33 and *25·1.

*25·32. *Proposition.*—Assuming (II–VII, IX–XI) H*p* R, if u be an interpoint, there is one and only one point containing it. In symbols,

$$\vdash .\therefore \text{(II–VII, IX–XI) H}p\ \text{R} . \supset : u \in \text{intpnt}_{Rt} . \supset . \text{P}\{\text{P} \in \text{pnt}_{Rt} . u \subset \text{P}\} \in 1$$

Proof.—Cf. *1·71 and *14·21 and *22·32.

*26. *On Cogredient Points.*

*26·11. *Proposition.*—Assuming (II–VI, IX–XI, XIII) H*p* R, if a point possesses two members which are cogredient to each other, it is a cogredient point. In symbols,

$$\vdash .\therefore \text{(II–VI, IX–XI, XIII) H}p\ \text{R} . \supset :$$
$$\text{A} \in \text{pnt}_{Rt} . a, b \in \text{A} . b \in \text{cogrd}_{Rt}\text{`}a . a \neq b . \supset . \text{A} \in \infty_{Rt}$$

Proof.—Cf. *14·21 and *20·42 and *22·61.

*26·22. *Proposition.*—Assuming (II–VI, IX–XI, XIII) H*p* R, if A is a cogredient point and a is a member of A, then A is identical with $\iota\text{`}a \cup \text{cogrd}_{Rt}\text{`}a$. In symbols,

$$\vdash .\therefore \text{(II–VI, IX–XI, XIII) H}p\ \text{R} .$$
$$: \text{A} \in \infty_{Rt} . a \in \text{A} . \subset . \text{A} = \iota\text{`}a \cup \text{cogrd}_{Rt}\text{`}a$$

Proof.—Cf. *14·21 and *20·42 and *21·41 and *22·61.

*26·23. *Proposition.*—Assuming (II–VI, IX–XI, XIII) Hp R, there is one and only one cogredient point lying in the punctual associate of an objective real. In symbols,

$$\vdash .\therefore (\text{II–VI, IX–XI, XIII})\ \text{H}p\ \text{R} . \supset : a \in \text{O}_{\text{R}t} . \supset . \infty_{\text{R}t} \cap \text{ass}_{\text{R}t}\text{`}\iota\text{`}a \in 1$$

Proof.—Cf. *26·22.

*26·24. *Proposition.*—Assuming (II–XI, XIII) Hp R, there are at least two points, not cogredient points, lying in the punctual associate of an objective real. In symbols,

$$\vdash .\therefore (\text{II–XI, XIII})\ \text{H}p\ \text{R} . \supset : a \in \text{O}_{\text{R}t} . \supset . \text{Nc}\text{`}\{\text{ass}_{\text{R}t}\text{`}\iota\text{`}a - \infty_{\text{R}t}\} \geqq 2$$

Proof.—Cf. *25·31 and *26·23.

*27. *On Punctual Lines.*

*27·11. *Proposition.*—Assuming (II–VI, IX–XI) Hp R, if p and q are distinct planes, and $p \cap q$ possesses a member, then $\text{ass}_{\text{R}t}\text{`}p \cap \text{ass}_{\text{R}t}\text{`}q$ is identical with $\text{ass}_{\text{R}t}\text{`}(p \cap q)$. In symbols,

$$\vdash .\therefore (\text{II–VI, IX–XI})\ \text{H}p\ \text{R} . \supset :$$
$$p, q \in \text{ple}_{\text{R}t} . p \neq q . \exists !(p \cap q) . \supset . \text{ass}_{\text{R}t}\text{`}p \cap \text{ass}_{\text{R}t}\text{`}q = \text{ass}_{\text{R}t}\text{`}(p \cap q)$$

Proof.—Cf. *16·33 and *20·21.

*27·12. *Proposition.*—Assuming (II–VI, IX–XII) Hp R, if p and q are distinct planes, and a point, not a cogredient point, lies in the punctual associates both of p and also of q, then $p \cap q$ possesses one and only one member. In symbols,

$$\vdash .\therefore (\text{II–VI, IX–XII})\ \text{H}p\ \text{R} . \supset :$$
$$p, q \in \text{ple}_{\text{R}t} . p \neq q . \exists !\{(\text{ass}_{\text{R}t}\text{`}p \cap \text{ass}_{\text{R}t}\text{`}q) - \infty_{\text{R}t}\} . \supset . p \cap q \in 1$$

Proof.—Cf. *16·21 and *22·51.

*27·13. *Proposition.*—Assuming (II–XIII) Hp R, if p and q are distinct planes, then if $p \cap q$ possesses one member, there are non-cogredient points lying in the punctual associates both of p and of q; and also conversely. In symbols,

$$\vdash : : (\text{II–XIII})\ \text{H}p\ \text{R} . \supset .\therefore p, q \in \text{ple}_{\text{R}t} . p \neq q . \supset :$$
$$\exists !\{(\text{ass}_{\text{R}t}\text{`}p \cap \text{ass}_{\text{R}t}\text{`}q) - \infty_{\text{R}t}\} . \equiv . p \cap q \in 1$$

Proof.—Cf. *26·24 and *27·12.

*27·21. *Proposition.*—Assuming (II–VI, IX–XII) Hp R, if m is a punctual line possessing a non-cogredient point, then there exists an objective real such that m is its punctual associate. In symbols,

$$\vdash .\therefore (\text{II–VI, IX–XII})\ \text{H}p\ \text{R} .\supset :$$
$$m \in \text{lin}_{\text{R}t} . \exists !(m = \infty_{\text{R}t}) . \supset . (\exists a) . a \in \text{O}_{\text{R}t} . m = \text{ass}_{\text{R}t}`\iota`a$$

Proof.—Cf. *27·11·12.

*27·22. *Proposition.*—Assuming (II–XIII) H*p* R, a punctual line possesses either more than one non-cogredient point or no such point. In symbols,

$$\vdash .\therefore (\text{II–XIII})\ \text{H}p\ \text{R} .\supset : m \in \text{lin}_{\text{R}t} . \exists !\{m = \infty_{\text{R}t}\} . \supset . \text{Nc}`(m = \infty_{\text{R}t}) > 1$$

Proof.—Cf. *20·22 and *26·24 and *27·21.

*27·23. *Proposition.*—Assuming (II–VI, IX–XIII) H*p* R, a punctual line, possessing a non-cogredient point, possesses one and only one cogredient point. In symbols,

$$\vdash .\therefore (\text{II–VI, IX–XIII})\ \text{H}p\ \text{R} .\supset : m \in \text{lin}_{\text{R}t} . \exists !(m = \infty_{\text{R}t}) . \supset . m \cap \infty_{\text{R}t} \in 1$$

Proof.—Cf. *26·23 and *27·21.

*27·31. *Proposition.*—Assuming (II–VI, IX–XII) H*p* R, if *m* is a punctual line possessing a non-cogredient point, and A and B are two distinct points lying in it, then *m* is the punctual associate of A ∩ B. In symbols,

$$\vdash .\therefore (\text{II–VI, IX–XII})\ \text{H}p\ \text{R} .\supset :$$
$$m \in \text{lin}_{\text{R}t} . \exists !(m = \infty_{\text{R}t}) . \text{A, B} \in m . \text{A} \neq \text{B} . \supset . m \in \text{ass}_{\text{R}t}`(\text{A} \cap \text{B})$$

Proof.—Cf. *14·21 and *27·11·12.

*27·41. *Proposition.*—Assuming (II–XI) H*p* R, if *a* is any objective real, then there exist two planes *p* and *q* such that *a* is the sole member of $p \cap q$. In symbols,

$$\vdash .\therefore (\text{II–XI})\ \text{H}p\ \text{R} .\supset : a \in \text{O}_{\text{R}t} . \supset . (\exists p, q) . p, q \in \text{ple}_{\text{R}t} . p \cap q = \iota`a$$

Proof.—Cf. *12·21 and *14·12·14 and *22·41 and *25·31.

*27·42. *Proposition.*—Assuming (II–XIII) H*p* R, if *a* be an objective real, then $\text{ass}_{\text{R}t}`\iota`a$ is a punctual line with a non-cogredient point, and conversely, if *m* is a punctual line with a non-cogredient point, there exists an objective real *a* such that $m = \text{ass}_{\text{R}t}`\iota`a$. In symbols,

$$\vdash .\therefore (\text{II–XIII})\ \text{H}p\ \text{R} .\supset : m \in \text{lin}_{\text{R}t} . \exists !(m = \infty_{\text{R}t}) . \equiv . (\exists a) .$$
$$a \in \text{O}_{\text{R}t} . m = \text{ass}_{\text{R}t}`\iota`a$$

Proof.—Cf. *27·11·13·21·41.

Note.—This proposition, *27·42, establishes the connection between the objective reals and the punctual lines.

*27·43. *Proposition.*—Assuming (II–XIII) H*p* R, if a and c are cogredient, they are distinct. In symbols,

$$\vdash .\therefore (\text{II–XIII})\ \text{H}p\ \text{R} . \supset : c \in \text{cogrd}_{\text{R}t}`a . \supset . a \neq c$$

Proof.—Cf. *20·31·41 and *27·42.

*27·51. *Proposition.*—Assuming (II–XIV) H*p* R, if A is any non-cogredient point and B is any other point, then $\text{A} \cap \text{B}$ possesses one and only one member. In symbols,

$$\vdash .\therefore (\text{II–XIV})\ \text{H}p\ \text{R} . \supset : \text{A} \in \text{pnt}_{\text{R}t} - \infty_{\text{R}t} . \text{B} \in \text{pnt}_{\text{R}t} . \text{A} \neq \text{B} . \supset . \text{A} \cap \text{B} \in 1$$

Proof.—(i) If B is non-cogredient, cf. *14·21 and *20·51 and *22·71. (ii) If B is cogredient, then (cf. *14·14) let b be a member of B. Then (cf. *26·24) there is on b a non-cogredient point D. Hence by (i) $\text{A} \cap \text{D}$ possesses a single objective real, d say. Hence (cf. *14·12) b and d are coplanar and $\text{cm}_{\text{R}t}`(\iota`b \cup \iota`d)$ is a plane whose punctual associate possesses both A and B. Also, since a point is three-dimensional, B possesses another objective real, $c$ say, not coplanar with $b$ and $d$. Hence by similar reasoning $\text{cm}_{\text{R}t}`(\iota`b \cup \iota`c)$ is a plane, not identical with $\text{cm}_{\text{R}t}`(\iota`b \cup \iota`d)$, whose punctual associate also possesses A and B. Hence (cf. *27·13) these two planes have one objective real in common, and hence (cf. *16·33) this objective real is a member of $\text{A} \cap \text{B}$, and hence (cf. *14·21) $\text{A} \cap \text{B}$ possesses one and only one member.

*27·52. *Proposition.*—Assuming (II–XIV) H*p* R, if A be a non-cogredient point and B be any other point, then $\text{ass}_{\text{R}t}`(\text{A} \cap \text{B})$ is a punctual line with a non-cogredient point, and conversely, if $m$ be a punctual line with a non-cogredient point, then there exist two points A and B, such that A is not cogredient and $m$ is identical with $\text{ass}_{\text{R}t}`(\text{A} \cap \text{B})$. In symbols,

$$\vdash .\therefore (\text{II–XIV})\ \text{H}p\ \text{R} . \supset : m \in \text{lin}_{\text{R}t} . \exists !(m - \infty_{\text{R}t}) . \equiv .$$
$$(\exists \text{A}, \text{B}) . \text{A} \in \text{pnt}_{\text{R}t} - \infty_{\text{R}t} . \text{B} \in \text{pnt}_{\text{R}t} . \text{A} \neq \text{B} . m = \text{ass}_{\text{R}t}`(\text{A} \cap \text{B})$$

Proof.—Cf. *27·22·31·42·51.

*28. *On Figures.*

*28.01. *Proposition.*—Assuming (II–VI, IX–XI) H*p* R, if t be an instant of time, there exists at least one punctual plane, not the plane $\infty_{\text{R}t}$. In symbols,

$$\vdash .\therefore (\text{II–VI, IX–XI})\ \text{H}p\ \text{R} .\supset : t \in \text{T} .\supset . \exists !(\text{pple}_{\text{R}t} \text{ “ } \iota`\infty_{\text{R}t})$$

Proof.—Cf. *12·42 and *22·41.

*28·11. *Proposition.*—Assuming (II–XIII) H*p* R, if *p* be any punctual plane, not the plane $\infty_{\text{R}t}$, it possesses at least three non-cogredient points, which are not collinear. In symbols,

$$\vdash .\therefore (\text{II–XIII})\ \text{H}p\ \text{R} .\supset : p \in \text{pple}_{\text{R}t} \text{ “ } \iota`\infty_{\text{R}t} .\supset .$$
$$(\exists u) . u \in (3 \cap \text{cls}`p). u \cap \infty_{\text{R}t} = \Lambda . \backsim \text{coll}_{\text{R}t}!u$$

Proof.—Cf. *14·21 and *26·24 and *27·21·31.

Note.—Cf. *16·42 and the note on it.

*28·12. *Proposition.*—Assuming (II–XIII) H*p* R, if *p* be any punctual plane, not the plane $\infty_{\text{R}t}$, there exists at least one non-cogredient point not lying in it. In symbols,

$$\vdash .\therefore (\text{II–XIII})\ \text{H}p\ \text{R} .\supset : p \in \text{pple}_{\text{R}t} \text{ “ } \iota`\infty_{\text{R}t} .\supset . (\exists \text{A}) . \text{A} \in (\text{pnt}_{\text{R}t} \text{ “ } \infty_{\text{R}t}) \text{ “ } p$$

Proof.—Cf. *12·21 and *16·32 and *22·41 and *26·24 and *28·11.

*28·21. *Proposition.*—Assuming (II–XIV) H*p* R, if *x* be any objective real and *p* be any plane, then either the punctual associates of *x* and *p* have one and only one common member, or *x* is a member of *p*. In symbols,

$$\vdash : : (\text{II–XIV})\ \text{H}p\ \text{R} .\supset .\therefore x \in \text{O}_{\text{R}t} . p \in \text{ple}_{\text{R}t} .\supset :$$
$$\text{ass}_{\text{R}t}`\iota`x \cap \text{ass}_{\text{R}t}`p \in 1 . \vee . x \in p$$

Proof.—Take (cf. *26·24 and *28·11) two non-cogredient points A and B upon *x*, and a non-cogredient point C in $\text{ass}_{\text{R}t}`p$ but not on *x*. If either A or B lie in $\text{ass}_{\text{R}t}`p$, then cf. *16·32. If neither A nor B lie in $\text{ass}_{\text{R}t}`p$, then (cf. *16·32 and *27·51) $\text{cm}_{\text{R}t}`\{(\text{B} \cap \text{C}) \cup (\text{A} \cap \text{C})\}$ is a plane possessing *x*, and its punctual associate possesses C. Hence (cf. *22·51) there is a common member of *p* and this plane, *y* say, and *x* and *y* are coplanar, hence (cf. *10·4 and *16·11) the punctual associates of *x* and *y* possess a common point. Hence $\text{ass}_{\text{R}t}`\iota`x$ and $\text{ass}_{\text{R}t}`p$ possess a point in common, and then cf. *16·32.

*28·22. *Proposition.*—Assuming (II–XIV) H*p* R, if *p* and *q* are punctual planes, and *p* is not identical with $\infty_{\text{R}t}$, and $p \cap q$ is contained in $\infty_{\text{R}t}$, then $p \cap q$ and $p \cap \infty_{\text{R}t}$ are identical. In symbols,

$$\vdash .\therefore (\text{II–XIV})\ \text{H}p\ \text{R} .\supset : p, q \in \text{pple}_{\text{R}t} . p \neq \infty_{\text{R}t} . p \cap q \subset \infty_{\text{R}t} .\supset .$$
$$p \cap q = p \cap \infty_{\text{R}t}$$

Proof.—If p and q are identical, then $p \subset \infty_{\mathrm{R}t}$, but (cf. *28·11) this is impossible. Hence $p \neq q$. If $q = \infty_{\mathrm{R}t}$, then $p \cap q = p \cap \infty_{\mathrm{R}t}$. Assume $q \neq \infty_{\mathrm{R}t}$. Then (cf. *20·61) there exist planes, p' and q' say, such that p is $\mathrm{ass}_{\mathrm{R}t}$'$p'$ and $q = \mathrm{ass}_{\mathrm{R}t}$'$q'$. Since $p \cap q \subset \infty_{\mathrm{R}t}$, there is (cf. *26·24) no objective real common to p' and q'. Hence (cf. *28·21) upon every objective real possessed by p' there is one and only one point lying in q. Hence (cf. *26·23) $p \cap q = p \cap \infty_{\mathrm{R}t}$.

*28·31. *Proposition.*—Assuming (II–XIV) Hp R, in every punctual line there lie at least three points. In symbols,

$$\vdash \therefore (\text{II–XIV})\ \mathrm{H}p\ \mathrm{R}\ .\supset : m \in \mathrm{lin}_{\mathrm{R}t}\ .\supset .\ \mathrm{Nc}'m \geqq 3$$

Proof.—If m possesses non-cogredient points, then cf. *27·22·23. If m is contained in $\infty_{\mathrm{R}t}$, then (cf. *28·22) m is identical with $p \cap \infty_{\mathrm{R}t}$, where p is a punctual plane. But (cf. *27·51·52 and *28·11) there are three distinct punctual lines contained in p, meeting two by two in three non-cogredient points; then cf. *27·23.

*28·32. *Proposition.*—Assuming (II–XIV) Hp R, a punctual line is the common meeting of two punctual planes, and conversely. In symbols,

$$\vdash \therefore (\text{II–XIV})\ \mathrm{H}p\ \mathrm{R}\ .\supset : \mathrm{lin}_{\mathrm{R}t} = \dot{m}\{(\exists p, q)\ .\ p, q \in \mathrm{pple}_{\mathrm{R}t}\ .\ p \neq q\ .\ m = p \cap q\}$$

Proof.—The direct proposition follows from *20·22·61. For the converse, let p and q be a pair of punctual planes. If neither p nor q be $\infty_{\mathrm{R}t}$, then cf. *20·22·61. Consider now $p \cap \infty_{\mathrm{R}t}$, where p is distinct from $\infty_{\mathrm{R}t}$. Take (cf. *28·12) a non-cogredient point A, not in p. Also (cf. *proof* of *28·31) there are two distinct points B and C in $p \cap \infty_{\mathrm{R}t}$. Hence (cf. *27·51) $\mathrm{cm}_{\mathrm{R}t}$'$\{(\mathrm{A} \cap \mathrm{B}) \cup (\mathrm{A} \cap \mathrm{C})\}$ is a plane, and its punctual associate, q say, possesses A and B and is distinct from p. Hence (cf. *27·23 and *28·22) $p \cap q$ is identical with $p \cap \infty_{\mathrm{R}t}$. But (cf. *28·22) $p \cap q$ is a punctual line, and hence $p \cap \infty_{\mathrm{R}t}$ is a punctual line.

*28·33. *Proposition.*—Assuming (II–XIV) Hp R, two distinct points lie in one and only one punctual line. In symbols,

$$\vdash \therefore (\text{II–XIV})\ \mathrm{H}p\ \mathrm{R}\ .\supset : \mathrm{A}, \mathrm{B} \in \mathrm{pnt}_{\mathrm{R}t}\ .\ \mathrm{A} \neq \mathrm{B}\ .\supset .\ m\{m \in \mathrm{lin}_{\mathrm{R}t}\ .\ \mathrm{A}, \mathrm{B} \in m\} \in 1$$

Proof.—Firstly, only one punctual line (if any) possesses both A and B (cf. *27·31 and *28·22·32). Secondly, to prove that a punctual line

exists possessing both A and B. If either point is non-cogredient, cf. *27·52. If both points are cogredient, then (cf. *28·11·12) two non-cogredient points C and D exist such that the four points A, B, C, D are not punctually coplanar. Hence (cf. *27·51) the meeting of the punctual associates of $\mathrm{cm}_{\mathrm{R}\iota}$‘$\{(\mathrm{A} \cap \mathrm{C}) \cup (\mathrm{B} \cap \mathrm{C})\}$ and of $\mathrm{cm}_{\mathrm{R}\iota}$‘$\{(\mathrm{A} \cap \mathrm{D}) \cup (\mathrm{B} \cap \mathrm{D})\}$ is a punctual line possessing A and B.

*28·41. *Proposition.*—Assuming (II–XIV) Hp R, three points, which are not collinear, lie in one and only one plane. In symbols,

$$\vdash .\therefore \text{(II–XIV) H}p\ \mathrm{R} . \supset : u \in 3 \cap \mathrm{pnt}_{\mathrm{R}\iota} . \backsim \mathrm{coll}_{\mathrm{R}\iota}!u . \supset . \dot{p}\{p \in \mathrm{pple}_{\mathrm{R}\iota} . u \subset p\} \in 1$$

Proof.—If the three points are all cogredient, then (cf. *28·22·32) $\infty_{\mathrm{R}\iota}$ is the only punctual plane which possesses them all. If the three points are A, B, C, and A be non-cogredient, then (cf. *27·51 and *28·32) the punctual associate of $\mathrm{cm}_{\mathrm{R}\iota}$‘$\{(\mathrm{A} \cap \mathrm{B}) \cup (\mathrm{A} \cap \mathrm{C})\}$ is a punctual plane, possessing A, B, and C, and is the only one.

*28·42. *Proposition.*—Assuming (II–XIV) Hp R, three punctual planes, which do not meet in a punctual line, meet in one point. In symbols,

$$\vdash .\therefore \text{(II–XIV) H}p\ \mathrm{R} . \supset : u \in 3 \cap \mathrm{cls}‘\mathrm{pple}_{\mathrm{R}\iota} . \supset . \cap ‘u \in \mathrm{lin}_{\mathrm{R}\iota} \cup 1$$

Proof.—Let p, q, r be the three punctual planes. Assume that p and q are neither the punctual plane $\infty_{\mathrm{R}\iota}$. If $q \cap r$ is contained in $\infty_{\mathrm{R}\iota}$, then cf. *20·22·61 and *27·23 and *28·22·32. If $q \cap r$ is not contained in $\infty_{\mathrm{R}\iota}$, then cf. *27·12 and *28·21.

*30. *Perspective.*

A few propositions on perspective (cf. *20·31·32·33) are required as a preliminary to the discussion of the point-ordering relation (cf. *20·51).

*30·1. *Proposition.*—Assuming (II–XIV) Hp R, if two figures are in perspective, their cardinal numbers are equal and each greater than one. In symbols,

$$\vdash .\therefore \text{(II–XIV) H}p\ \mathrm{R} . \supset : u\ \mathrm{persp}_{\mathrm{R}\iota}\ v . \supset . \mathrm{Nc}‘u = \mathrm{Nc}‘v . \mathrm{Nc}‘u > 1$$

Proof.—The equality of the cardinal numbers follows from the definition; also if both figures were unit classes, then (cf. *28·33) they would be collinear.

*30·3. *Proposition.*—Assuming (II–XIV) Hp R, if the figure u is in

perspective with the figure v, and also with the figure w, and if u, v, w are respectively collinear, and the punctual lines respectively containing u, v, w possess a common meeting, then either v is in perspective with w, or the joint class of v and w (i.e., $v \cup w$) is collinear. In symbols,

$$\vdash : : (\text{II–XIV})\ \text{H}p\ \text{R} \,.\, \supset \therefore u\ \text{persp}_{\text{R}t}\ v \,.\, u\ \text{persp}_{\text{R}t}\ v \,.\, m, m', m'' \in \text{lin}_{\text{R}t} \,.$$
$$u \subset m \,.\, v \subset m' \,.\, w \subset m'' \,.\, \exists!(m \cap m' \cap m'') \,.\, \supset : v\ \text{persp}_{\text{R}t}\ w \,.\, \vee \,.\, m' = m''$$

Proof.—Desargues' well-known propositions respecting triangles in perspective being coaxial, and its converse, can now (cf. *28·11·12·31·32·33·41·42) be proved. Then by drawing a figure for the present proposition the conclusion easily follows from some pure geometrical reasoning.

*31. *The Point-Ordering Relation.*

It will be proved in this section that the point-ordering relation (R_{pn}) has at any instant the same properties as the essential relation of Concept I (cf. *31·3). It follows that the ordinary Euclidean geometry holds of the figures of Concept V, the points at infinity being the points of the punctual plane $\infty_{\text{R}t}$, and the metrical ideas being introduced by appropriate definitions.

*31·11. *Proposition.*—Assuming (II–XI, XIII, XIV) Hp R, the class $\text{R}_{\text{pn}}{}^{\text{i}}(;;;t)$ is identical with the class of non-cogredient points. In symbols,

$$\vdash \therefore (\text{II–XI, XIII, XIV})\ \text{H}p\ \text{R} \,.\, \supset \,.\, \text{R}_{\text{pn}}{}^{\text{i}}(;;;t) = \text{pnt}_{\text{R}t} - \infty_{\text{R}t}$$

Proof.—Cf. *3·42 and *20·51 and *22·71 and *26·24.

*31·12. *Proposition.* Assuming (II–XV) Hp R, if a is a punctual line, and A and B are two non-cogredient points on it, then a, without its cogredient point, is identical with the whole class formed by $\text{R}_{\text{pn}}{}^{\text{i}}(;\text{AB}t)$ and $\text{R}_{\text{pn}}{}^{\text{i}}(\text{A};\text{B}t)$ and $\text{R}^{\text{i}}(\text{AB};t)$ together with A and B added as members. In symbols,

$$\vdash \therefore (\text{II–XV})\ \text{H}p\ \text{R} \,.\, \supset : a \in \text{lin}_{\text{R}t} \,.\, \text{A}, \text{B} \in a - \infty_{\text{R}t} \,.\, \text{A} \neq \text{B} \,.\, \supset \,.\, a - \infty_{\text{R}t} =$$
$$\text{R}_{\text{pn}}{}^{\text{i}}(;\text{AB}t) \cup \text{R}_{\text{pn}}{}^{\text{i}}(\text{A};\text{B}t) \cup \text{R}_{\text{pn}}{}^{\text{i}}(\text{AB};t) \cup \iota\text{`A} \cup \iota\text{`B}$$

Proof.—The identity is to be proved by showing that each class contains the other. For one half of the proof, cf. *22·72 and *27·21. For the other half, cf. *20·51 and *27·21·31.

*31·21. *Proposition.*—Assuming (II–VI) Hp R, the point-order ABC implies the point-order CBA. In symbols,

$$\vdash \therefore (\text{II–VI})\ \text{H}p\ \text{R} \,.\, \supset : \text{R}_{\text{pn}}{}^{\text{i}}(\text{ABC}t) \,.\, \supset \,.\, \text{R}_{\text{pn}}{}^{\text{i}}(\text{CBA}t)$$

Proof.—Cf. *1·63 and *20·51.

*31·22. *Proposition.*—Assuming (II–VII, IX–XI) H*p* R, if A, B, C are in the point-order ABC, then A, B, and C are distinct. In symbols,

$$\vdash .\therefore (\text{II–VII, IX–XI})\ \text{H}p\ \text{R} . \supset : \text{R}_{\text{pn}}{}^{i}(\text{ABC}t) . \supset . \text{A} \neq \text{B} . \text{A} \neq \text{C} . \text{B} \neq \text{C}$$

Proof.—There are (cf. *20·51) interpoints u, v, w on a common objective real a, such that $\text{R}_{\text{in}}{}^{i}(uvwt)$ and $[\text{ABC}]\ \text{persp}_{\text{R}t}\ [u_{\text{R}t}v_{\text{R}t}w_{\text{R}t}]$, where (cf. *20·23 and *25·32) $u_{\text{R}t}$, $v_{\text{R}t}$, $w_{\text{R}t}$ are the dominant points of u, v, w. But (cf. *1·62 and *22·33) $u_{\text{R}t}$, $v_{\text{R}t}$, $w_{\text{R}t}$ are distinct points. Hence (cf. *20·32) A, B, C are distinct points.

*31·23. *Proposition.*—Assuming (II–XV) H*p* R, the point-order ABC is inconsistent with the point-order BCA. In symbols,

$$\vdash .\therefore (\text{II–XV})\ \text{H}p\ \text{R} . \quad : \text{R}_{\text{pn}}{}^{i}(\text{ABC}t) . \supset . \backsim \text{R}^{i}(\text{BCA}t)$$

Proof.—Since this proof is long, the paragraphs will be numbered for reference by (i), (ii), &c., prefixed.

(i) If u, v, w are interpoints on the objective real a, and u', v', w' interpoints on the objective real a', and a and a' are cogredient, and $[u_{\text{R}t}v_{\text{R}t}w_{\text{R}t}]\ \text{persp}_{\text{R}t}\ [u'_{\text{R}t}v'_{\text{R}t}w'_{\text{R}t}]$, then (cf. *20·23·41 and *25·32) u, v, w and u', v', w' must agree in interpoint order, and (cf. *1·64) each set of interpoints has only one (if any) interpoint order (counting uvw and wvu as the same order), and (cf. *27·43) a and a' are distinct.

(ii) From *20·51, $\text{R}_{\text{pn}}{}^{i}(\text{ABC}t)$ implies (α) that A, B, C are on an object real d; (β) that there are interpoints u, v, w on an objective real a, cogredient with d; (γ) that $\text{R}_{\text{in}}{}^{i}(uvwt)$; ($\delta$) that $[\text{ABC}]\ \text{persp}_{\text{R}t}\ [u_{\text{R}t}v_{\text{R}t}w_{\text{R}t}]$; and ($\epsilon$) (cf. *27·43) that a and d are distinct.

(iii) Assume that $\text{R}_{\text{pn}}{}^{i}(\text{BCA}t)$ also holds. Then, in addition to the entities of (ii), there exist interpoints u', v', w' on an objective real a', satisfying all the conditions of (ii) without changes, except that (ii, γ) becomes $\text{R}_{\text{in}}{}^{i}(v'w'u't)$. This assumption (iii) will now be proved to be absurd.

(iv) From XIII H*p* R (cf. *22·61) and *26·11·22, d, a, a' are copunctual and a and a' are either cogredient or identical.

(v) Hence (cf. *30·3) *either* (Case I) $[u_{\text{R}t}v_{\text{R}t}w_{\text{R}t}]\ \text{persp}_{\text{R}t}\ [u'_{\text{R}t}v'_{\text{R}t}w'_{\text{R}t}]$ *or* (Case II), a and a' are identical.

(vi) *Case I.*—We have $[u_{\text{R}t}v_{\text{R}t}w_{\text{R}t}]\ \text{persp}_{\text{R}t}\ [u'_{\text{R}t}v'_{\text{R}t}w'_{\text{R}t}]$. Hence (cf. *20·41) the interpoint orders of u, v, w and u', v', w' must agree. Hence, from (ii, γ), $\text{R}_{\text{in}}{}^{i}(u'v'w't)$ holds. But (cf. *1·64) this is inconsistent with $\text{R}_{\text{in}}{}^{i}(v'w'u't)$. Hence Case I cannot hold.

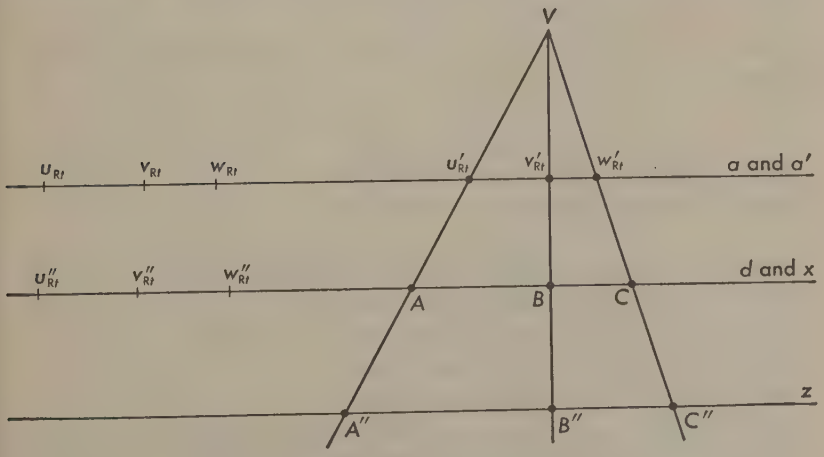
(vii) *Case II.*—We have a and a' identical. Now (cf. *31·22) A, B, C

are distinct points. Hence [cf. (ii, δ) and *30·1] u_{Rt}, v_{Rt}, w_{Rt} are distinct points, and [cf. (ii, β)] they are collinear. Hence, by XV Hp R (cf. *22·72), they are in some point-order. Hence [cf. (ii)] three interpoints u'', v'', w'' exist on a common objective real x, which is distinct from a and cogredient with it, and also $[u''_{Rt}v''_{Rt}w''_{Rt}]$ persp_{Rt} $[u_{Rt}v_{Rt}w_{Rt}]$.

(viii) Hence Case II divides into two subclasses, *either* (*Case II*, α) x is not identical with d, *or* (*Case II*, β) x is identical with d.

(ix) *Case II*, α.—a and a' are identical and distinct from both d and x, and d and x are distinct; also a, d, x are cogredient and therefore (cf. *26·11·22) copunctual. Hence [cf. (ii, δ) and (vii) and *30·3] we have [ABC] persp_{Rt} $[u''_{Rt}v''_{Rt}w''_{Rt}]$. Hence [cf. (iii, δ) and *30·3] $[u'_{Rt}v'_{Rt}w'_{Rt}]$ $\text{persp}_{Rt}[u''_{Rt}v''_{Rt}w''_{Rt}]$. Hence [cf. *20·41 and (ii, γ) and (vii)] $R_{in}{}^{i}(u'v'w't)$. Hence (cf. *1·64) Case II., α, cannot hold.

(x) *Case II*, β.—a and a' are identical, x and d are identical, and a and d are cogredient and distinct. Since (cf. *20·51) A, B, C are not cogredient points, they are distinct from u'_R, v'_R, w'_R, since the only point common to the punctual associates of a and d is a cogredient point. Thus none of u'_{Rt}, v'_{Rt}, w'_{Rt} can be cogredient points. Hence (cf. *28·33) there is a punctual line joining B and w'_{Rt} which does not possess A or u'_{Rt} or V (cf. figure annexed). Hence (cf. *28·42) there is at



least one other point, A″ say, lying in the punctual line joining A and u'_{Rt} in addition to V and u'_{Rt} and A. Hence (cf. *28·33) there is a punctual line, z say, joining A″ to the cogredient point common to the

punctual associates of a and d. This punctual line must meet (cf. *28·42) the punctual lines VB and VC (cf. figure annexed) in the points B″ and C″. Hence

$$[A''B''C'']\ \mathrm{persp}_{Rt}\ [ABC],$$

and hence (cf. *30·3) we have

$$[A''B''C'']\ \mathrm{persp}_{Rt}\ [u_{Rt}v_{Rt}w_{Rt}],$$

and hence (cf. *30·3) we have

$$[A''B''C'']\ \mathrm{persp}_{Rt}\ [u''_{Rt}v''_{Rt}w''_{Rt}].$$

But also

$$[A''B''C'']\ \mathrm{persp}_{Rt}\ [u'_{Rt}v'_{Rt}w'_{Rt}],$$

and hence (cf. *30·3) we have

$$[u'_{Rt}v'_{Rt}w'_{Rt}]\ \mathrm{persp}_{Rt}\ [u''_{Rt}v''_{Rt}w''_{Rt}].$$

Thence, by the same reasoning as that in (ix) for Case II, α, it follows that Case II, β, cannot hold.

(xi) Hence neither Case I nor Case II can hold; and therefore the proposition follows.

*31·3. *Proposition.*—The point-ordering relation (R_{pn}) satisfies all the axioms satisfied by the essential relation of Concept III, except the axiom of persistence for that concept.

Proof.—In order to prove this, we make a comparison, as in Concept III, with the axioms of Concept I.

For I H*p* R of Concept I, cf. *25·12 and *26·24 and *31·11.
For II H*p* R of Concept I, cf. *31·21.
For III H*p* R of Concept I, cf. *31·23.
For IV H*p* R of Concept I, cf. *31·22.
For V H*p* R of Concept I, cf. XIV H*p* R (*22·71).
For VI H*p* R of Concept I, cf. *28·33 and *31·12.
For VII H*p* R of Concept I, cf. *28·01·11.
For VIII H*p* R of Concept I, cf. XVI H*p* R (*22·73).
For IX H*p* R of Concept I, cf. *28·12.
For X H*p* R of Concept I, cf. *28·42.
For XI H*p* R of Concept I, cf. *XVII H*p* R (*22·74).
For XII H*p* R of Concept I, cf. *26·23 and *28·33.

Note.—In order to complete this comparison, it must be noticed that it follows from *31·12 that the punctual line, with its cogredient point excepted, is the line as defined on the analogy of Concept I. Also, it

follows, from *28·32 and *28·42 and the propositions of *31, that the punctual plane, with its cogredient points excepted, is the plane as defined on the analogy of Concept I. Then the transition to projective geometry is made, not by constructing a fresh type of points (the projective points), but simply by putting back the class ($\infty_{R\iota}$) of cogredient points. Metrical geometry is then constructed in the well-known way,* making the plane ($\infty_{R\iota}$) of cogredient points to be the plane at infinity.

The Extraneous Relation.—For the purpose of enabling velocity and acceleration to be measured, an extraneous relation is required, in all respects similar to those required in Concepts III and IV, and the description already given need not be repeated.

The Corpuscles.—We may distinguish five types of points. A point of *Type* (1) contains no interpoints, and consists only of its nonsecant part (cf. *20·231). A point of *Type* (2) contains a single interpoint and no nonsecant part. Such a point is a single interpoint. A point of *Type* (3) contains a single interpoint together with a nonsecant part. A point of *Type* (4) contains many interpoints with no nonsecant part. A point of *Type* (5) contains many interpoints together with a nonsecant point.

We seem to be precluded from considering the 'particles' to be stable points by the same difficulty as to the resulting permanence of collinearity, which was explained in considering the corpuscles of Concept IV. It is evident that at this stage many subdivisions of Concept V are possible, in respect to the ideas which may be formed of the nature of the corpuscle. The following sketch of a possible development is given because of its superior simplicity, and also because of a certain consonance which it possesses with some modern physical ideas.

It is evident that volumes, in which, in some sense, there is an excess or a defect of interpoints, can be conceived as being charged with one or other of the two sorts of electricity. This idea is taken as the basis of the following brief outline of a possible development of the concept. Let the interpoints be identified with negative electricity and the nonsecant parts of points with positive electricity. A point of type (1) is a negative electron; a point of type (2) is a positive electron. The persistence of existence of an isolated electron of either type is to be *defined* by persistence of type and continuity of motion. If the electron is not isolated, consider, for example, a volume in which electrons of type (2) either compose all the points, or, at least, are everywhere dense. Then

* Cf. Veblen, *loc. cit.*, for a sketch of this method; also Clebsch and Lindemann, *loc. cit.*

the persistence of such a collection of electrons must be considered as a whole, and is *defined*, as in the simpler case, by persistence of type and continuity of motion.

Three methods of procedure now suggest themselves, *either* (*Case I*) to assume that the electrons consist of single points, so that a corpuscle is a volume containing a large finite number of points of type (2), and a small finite number of points of type (1), *or* (*Case II*) to assume that a corpuscle is a volume in which points of type (2) are (at least) everywhere dense, and which contains a finite number of points of type (1), *or* (*Case III*) to assume that an electron of either type is essentially a volume (possibly with internal boundaries) in which points of the appropriate type are at least everywhere dense. In Case III a corpuscle will be a relatively large electron of type (2) containing within it a finite number of relatively small electrons of type (1). Case III has the merit, such as it is, of making the 'inverse square' law of electricity appear somewhat natural. The field of force 'at a point' produced by an electron may be conceived as proportional to the number of objective reals shared in common by the point and the 'electric points' in the electron, and also to the number of these electric points. The number of electric points would be measured by the mass of the electron, the number of objective reals by the solid angle subtended at the point by the electron.

What is wanted at this stage is some simple hypothesis concerning the motion of objective reals and correlating it with the motion of electric points and electrons. From such a hypothesis the whole electromagnetic and gravitational laws might follow with the utmost simplicity. The complete concept involves the assumption of only one class of entities as forming the universe. Properties of 'space' and of the physical phenomena 'in space' become simply the properties of this single class of entities. In regard to the simplification of the preceding axioms, viz., of (I–XVI) H*p* R, the ideal to be aimed at would be to deduce some or all of them from more general axioms which would also embrace the laws of physics. Thus these laws should not presuppose geometry, but create it.

The Aims of Education and Other Essays

Chapter I	The Aims of Education	87
Chapter IV	Technical Education and Its Relation to Science and Literature	100
Chapter V	The Place of Classics in Education	115
Chapter VII	Universities and Their Function	129
Chapter VIII	The Organisation of Thought	139

THE AIMS OF EDUCATION

In 1917 Whitehead published a volume entitled The Organization of Thought, which consisted of a number of lectures on various topics, ranging from the general theme of "The Aims of Education" to the more technical study of "Space, Time, and Relativity." In 1929 these essays were republished, with some deletions and minor corrections, and with new material, under the title The Aims of Education. The selections which follow here are from this second edition.

The first two essays selected for this anthology are Whitehead's presidential addresses to the Mathematical Association of England in 1916 and 1917 respectively. The third essay was originally published in the *Hibbert Journal* in 1923, while the fourth is an address delivered before the American Association of the Collegiate Schools of Business in 1927.

The fifth essay gave its title to the original volume in 1917, and is in itself an extremely interesting bridge in the passage of Whitehead's thought from the Principia Mathematica stage to the period of The Concept of Nature.

The essays omitted from this anthology include on the one hand a further development of Whitehead's thoughts on education, with particular reference to the mathematical curriculum, and on the other hand an extremely careful study of some basic scientific ideas—a study which was to be carried out in greater detail in his later books.

Culture is activity of thought, and receptiveness to beauty and humane feeling. Scraps of information have nothing to do with it. A merely well-informed man is the most useless bore on God's earth. What we should aim at producing is men who possess both culture and expert knowledge in some special direction. Their expert knowledge will give them the ground to start from, and their culture will lead them as deep as philosophy and as high as art. We have to remember that the valuable intellectual development is self-development, and that it mostly takes place between the ages of sixteen and thirty. As to training, the most important part is given by mothers before the age of twelve. A saying due to Archbishop Temple illustrates my meaning. Surprise was expressed at the success in after-life of a man, who as a boy at Rugby had been somewhat undistinguished. He answered, 'It is not what they are at eighteen, it is what they become afterwards that matters.'

In training a child to activity of thought, above all things we must beware of what I will call 'inert ideas'—that is to say, ideas that are merely received into the mind without being utilised, or tested, or thrown into fresh combinations.

In the history of education, the most striking phenomenon is that schools of learning, which at one epoch are alive with a ferment of genius, in a succeeding generation exhibit merely pedantry and routine. The reason is, that they are overladen with inert ideas. Education with inert ideas is not only useless: it is, above all things, harmful—*Corruptio optimi, pessima.* Except at rare intervals of intellectual ferment, education in the past has been radically infected with inert ideas. That is the reason why uneducated clever women, who have seen much of the world, are in middle life so much the most cultured part of the community. They have been saved from this horrible burden of inert ideas. Every intellectual revolution which has ever stirred humanity into greatness has been a passionate protest against inert ideas. Then, alas, with pathetic ignorance of human psychology, it has proceeded by some educational scheme to bind humanity afresh with inert ideas of its own fashioning.

Let us now ask how in our system of education we are to guard against this mental dryrot. We enunciate two educational commandments, 'Do not teach too many subjects,' and again, 'What you teach, teach thoroughly.'

The result of teaching small parts of a large number of subjects is the passive reception of disconnected ideas, not illumined with any spark of vitality. Let the main ideas which are introduced into a child's education be few and important, and let them be thrown into every combination possible. The child should make them his own, and should understand their application here and now in the circumstances of his actual life. From the very beginning of his education, the child should experience the joy of discovery. The discovery which he has to make, is that general ideas give an understanding of that stream of events which pours through his life, which is his life. By understanding I mean more than a mere logical analysis, though that is included. I mean 'understanding' in the sense in which it is used in the French proverb, 'To understand all, is to forgive all.' Pedants sneer at an education which is useful. But if education is not useful, what is it? Is it a talent, to be hidden away in a napkin? Of course, education should be useful, whatever your aim in life. It was useful to Saint Augustine and it was useful to Napoleon. It is useful, because understanding is useful.

I pass lightly over that understanding which should be given by the literary side of education. Nor do I wish to be supposed to pronounce on the relative merits of a classical or a modern curriculum. I would only remark that the understanding which we want is an understanding of an insistent present. The only use of a knowledge of the past is to equip us for the present. No more deadly harm can be done to young minds than by depreciation of the present. The present contains all that there is. It is holy ground; for it is the past, and it is the future. At the same time it must be observed that an age is no less past if it existed two hundred years ago than if it existed two thousand years ago. Do not be deceived by the pedantry of dates. The ages of Shakespeare and of Molière are no less past than are the ages of Sophocles and of Virgil. The communion of saints is a great and inspiring assemblage, but it has only one possible hall of meeting, and that is, the present; and the mere lapse of time through which any particular group of saints must travel to reach that meeting-place, makes very little difference.

Passing now to the scientific and logical side of education, we remember that here also ideas which are not utilised are positively harmful. By utilising an idea, I mean relating it to that stream, compounded of sense perceptions, feelings, hopes, desires, and of mental activities adjusting thought to thought, which forms our life. I can imagine a set of beings which might fortify their souls by passively reviewing disconnected ideas. Humanity is not built that way—except perhaps some editors of newspapers.

In scientific training, the first thing to do with an idea is to prove it. But allow me for one moment to extend the meaning of 'prove'; I mean—to prove its worth. Now an idea is not worth much unless the propositions in which it is embodied are true. Accordingly an essential part of the proof of an idea is the proof, either by experiment or by logic, of the truth of the propositions. But it is not essential that this proof of the truth should constitute the first introduction to the idea. After all, its assertion by the authority of respectable teachers is sufficient evidence to begin with. In our first contact with a set of propositions, we commence by appreciating their importance. That is what we all do in after-life. We do not attempt, in the strict sense, to prove or to disprove anything, unless its importance makes it worthy of that honour. These two processes of proof, in the narrow sense, and of appreciation, do not require a rigid separation in time. Both can be proceeded with nearly concurrently. But in so far as either process must have the priority, it should be that of appreciation by use.

Furthermore, we should not endeavour to use propositions in isolation. Emphatically I do not mean, a neat little set of experiments to illustrate Proposition I and then the proof of Proposition I, a neat little set of experiments to illustrate Proposition II and then the proof of Proposition II, and so on to the end of the book. Nothing could be more boring. Interrelated truths are utilised *en bloc,* and the various propositions are employed in any order, and with any reiteration. Choose some important applications of your theoretical subject; and study them concurrently with the systematic theoretical exposition. Keep the theoretical exposition short and simple, but let it be strict and rigid so far as it goes. It should not be too long for it to be easily known with thoroughness and accuracy. The consequences of a plethora of half-digested theoretical knowledge are deplorable. Also the theory should not be muddled up with

the practice. The child should have no doubt when it is proving and when it is utilising. My point is that what is proved should be utilised, and that what is utilised should—so far as is practicable—be proved. I am far from asserting that proof and utilisation are the same thing.

At this point of my discourse, I can most directly carry forward my argument in the outward form of a digression. We are only just realising that the art and science of education require a genius and a study of their own; and that this genius and this science are more than a bare knowledge of some branch of science or of literature. This truth was partially perceived in the past generation; and headmasters, somewhat crudely, were apt to supersede learning in their colleagues by requiring left-hand bowling and a taste for football. But culture is more than cricket, and more than football, and more than extent of knowledge.

Education is the acquisition of the art of the utilisation of knowledge. This is an art very difficult to impart. Whenever a text-book is written of real educational worth, you may be quite certain that some reviewer will say that it will be difficult to teach from it. Of course it will be difficult to teach from it. If it were easy, the book ought to be burned; for it cannot be educational. In education, as elsewhere, the broad primrose path leads to a nasty place. This evil path is represented by a book or a set of lectures which will practically enable the student to learn by heart all the questions likely to be asked at the next external examination. And I may say in passing that no educational system is possible unless every question directly asked of a pupil at any examination is either framed or modified by the actual teacher of that pupil in that subject. The external assessor may report on the curriculum or on the performance of the pupils, but never should be allowed to ask the pupil a question which has not been strictly supervised by the actual teacher, or at least inspired by a long conference with him. There are a few exceptions to this rule, but they are exceptions, and could easily be allowed for under the general rule.

We now return to my previous point, that theoretical ideas should always find important applications within the pupil's curriculum. This is not an easy doctrine to apply, but a very hard one. It contains within itself the problem of keeping knowledge alive, of pre-

venting it from becoming inert, which is the central problem of all education.

The best procedure will depend on several factors, none of which can be neglected, namely, the genius of the teacher, the intellectual type of the pupils, their prospects in life, the opportunities offered by the immediate surroundings of the school, and allied factors of this sort. It is for this reason that the uniform external examination is so deadly. We do not denounce it because we are cranks, and like denouncing established things. We are not so childish. Also, of course, such examinations have their use in testing slackness. Our reason of dislike is very definite and very practical. It kills the best part of culture. When you analyse in the light of experience the central task of education, you find that its successful accomplishment depends on a delicate adjustment of many variable factors. The reason is that we are dealing with human minds, and not with dead matter. The evocation of curiosity, of judgment, of the power of mastering a complicated tangle of circumstances, the use of theory in giving foresight in special cases—all these powers are not to be imparted by a set rule embodied in one schedule of examination subjects.

I appeal to you, as practical teachers. With good discipline, it is always possible to pump into the minds of a class a certain quantity of inert knowledge. You take a text-book and make them learn it. So far, so good. The child then knows how to solve a quadratic equation. But what is the point of teaching a child to solve a quadratic equation? There is a traditional answer to this question. It runs thus: The mind is an instrument, you first sharpen it, and then use it; the acquisition of the power of solving a quadratic equation is part of the process of sharpening the mind. Now there is just enough truth in this answer to have made it live through the ages. But for all its half-truth, it embodies a radical error which bids fair to stifle the genius of the modern world. I do not know who was first responsible for this analogy of the mind to a dead instrument. For aught I know, it may have been one of the seven wise men of Greece, or a committee of the whole lot of them. Whoever was the originator, there can be no doubt of the authority which it has acquired by the continuous approval bestowed upon it by eminent persons. But whatever its weight of authority, whatever the high ap-

proval which it can quote, I have no hesitation in denouncing it as one of the most fatal, erroneous, and dangerous conceptions ever introduced into the theory of education. The mind is never passive; it is a perpetual activity, delicate, receptive, responsive to stimulus. You cannot postpone its life until you have sharpened it. Whatever interest attaches to your subject-matter must be evoked here and now; whatever powers you are strengthening in the pupil, must be exercised here and now; whatever possibilities of mental life your teaching should impart, must be exhibited here and now. That is the golden rule of education, and a very difficult rule to follow.

The difficulty is just this: the apprehension of general ideas, intellectual habits of mind, and pleasurable interest in mental achievement can be evoked by no form of words, however accurately adjusted. All practical teachers know that education is a patient process of the mastery of details, minute by minute, hour by hour, day by day. There is no royal road to learning through an airy path of brilliant generalisations. There is a proverb about the difficulty of seeing the wood because of the trees. That difficulty is exactly the point which I am enforcing. The problem of education is to make the pupil see the wood by means of the trees.

The solution which I am urging, is to eradicate the fatal disconnection of subjects which kills the vitality of our modern curriculum. There is only one subject-matter for education, and that is Life in all its manifestations. Instead of this single unity, we offer children —Algebra, from which nothing follows; Geometry, from which nothing follows; Science, from which nothing follows; History, from which nothing follows; a Couple of Languages, never mastered; and lastly, most dreary of all, Literature, represented by plays of Shakespeare, with philological notes and short analyses of plot and character to be in substance committed to memory. Can such a list be said to represent Life, as it is known in the midst of the living of it? The best that can be said of it is, that it is a rapid table of contents which a deity might run over in his mind while he was thinking of creating a world, and had not yet determined how to put it together.

Let us now return to quadratic equations. We still have on hand the unanswered question. Why should children be taught their solution? Unless quadratic equations fit into a connected curriculum, of course there is no reason to teach anything about them. Furthermore, extensive as should be the place of mathematics in a complete cul-

ture, I am a little doubtful whether for many types of boys algebraic solutions of quadratic equations do not lie on the specialist side of mathematics. I may here remind you that as yet I have not said anything of the psychology or the content of the specialism, which is so necessary a part of an ideal education. But all that is an evasion of our real question, and I merely state it in order to avoid being misunderstood in my answer.

Quadratic equations are part of algebra, and algebra is the intellectual instrument which has been created for rendering clear the quantitative aspects of the world. There is no getting out of it. Through and through the world is infected with quantity. To talk sense, is to talk in quantities. It is no use saying that the nation is large,—How large? It is no use saying that radium is scarce,—How scarce? You cannot evade quantity. You may fly to poetry and to music, and quantity and number will face you in your rhythms and your octaves. Elegant intellects which despise the theory of quantity, are but half developed. They are more to be pitied than blamed. The scraps of gibberish, which in their school-days were taught to them in the name of algebra, deserve some contempt.

This question of the degeneration of algebra into gibberish, both in word and in fact, affords a pathetic instance of the uselessness of reforming educational schedules without a clear conception of the attributes which you wish to evoke in the living minds of the children. A few years ago there was an outcry that school algebra was in need of reform, but there was a general agreement that graphs would put everything right. So all sorts of things were extruded, and graphs were introduced. So far as I can see, with no sort of idea behind them, but just graphs. Now every examination paper has one or two questions on graphs. Personally, I am an enthusiastic adherent of graphs. But I wonder whether as yet we have gained very much. You cannot put life into any schedule of general education unless you succeed in exhibiting its relation to some essential characteristic of all intelligent or emotional perception. It is a hard saying, but it is true; and I do not see how to make it any easier. In making these little formal alterations you are beaten by the very nature of things. You are pitted against too skilful an adversary, who will see to it that the pea is always under the other thimble.

Reformation must begin at the other end. First, you must make up your mind as to those quantitative aspects of the world which

are simple enough to be introduced into general education; then a schedule of algebra should be framed which will about find its exemplification in these applications. We need not fear for our pet graphs, they will be there in plenty when we once begin to treat algebra as a serious means of studying the world. Some of the simplest applications will be found in the quantities which occur in the simplest study of society. The curves of history are more vivid and more informing than the dry catalogues of names and dates which comprise the greater part of that arid school study. What purpose is effected by a catalogue of undistinguished kings and queens? Tom, Dick, or Harry, they are all dead. General resurrections are failures, and are better postponed. The quantitative flux of the forces of modern society is capable of very simple exhibition. Meanwhile, the idea of the variable, of the function, of rate of change, of equations and their solution, of elimination, are being studied as an abstract science for their own sake. Not, of course, in the pompous phrases with which I am alluding to them here, but with that iteration of simple special cases proper to teaching.

If this course be followed, the route from Chaucer to the Black Death, from the Black Death to modern Labour troubles, will connect the tales of the mediæval pilgrims with the abstract science of algebra, both yielding diverse aspects of that single theme, Life. I know what most of you are thinking at this point. It is that the exact course which I have sketched out is not the particular one which you would have chosen, or even see how to work. I quite agree. I am not claiming that I could do it myself. But your objection is the precise reason why a common external examination system is fatal to education. The process of exhibiting the applications of knowledge must, for its success, essentially depend on the character of the pupils and the genius of the teacher. Of course I have left out the easiest applications with which most of us are more at home. I mean the quantitative sides of sciences, such as mechanics and physics.

Again, in the same connection we plot the statistics of social phenomena against the time. We then eliminate the time between suitable pairs. We can speculate how far we have exhibited a real causal connection, or how far a mere temporal coincidence. We notice that we might have plotted against the time one set of statistics for one country and another set for another country, and thus, with suitable choice of subjects, have obtained graphs which certainly exhibited

mere coincidence. Also other graphs exhibit obvious causal connections. We wonder how to discriminate. And so are drawn on as far as we will.

But in considering this description, I must beg you to remember what I have been insisting on above. In the first place, one train of thought will not suit all groups of children. For example, I should expect that artisan children will want something more concrete and, in a sense, swifter than I have set down here. Perhaps I am wrong, but that is what I should guess. In the second place, I am not contemplating one beautiful lecture stimulating, once and for all, an admiring class. That is not the way in which education proceeds. No; all the time the pupils are hard at work solving examples, drawing graphs, and making experiments, until they have a thorough hold on the whole subject. I am describing the interspersed explanations, the directions which should be given to their thoughts. The pupils have got to be made to feel that they are studying something, and are not merely executing intellectual minuets.

Finally, if you are teaching pupils for some general examination, the problem of sound teaching is greatly complicated. Have you ever noticed the zig-zag moulding round a Norman arch? The ancient work is beautiful, the modern work is hideous. The reason is, that the modern work is done to exact measure, the ancient work is varied according to the idiosyncrasy of the workman. Here it is crowded, and there it is expanded. Now the essence of getting pupils through examinations is to give equal weight to all parts of the schedule. But mankind is naturally specialist. One man sees a whole subject, where another can find only a few detached examples. I know that it seems contradictory to allow for specialism in a curriculum especially designed for a broad culture. Without contradictions the world would be simpler, and perhaps duller. But I am certain that in education wherever you exclude specialism you destroy life.

We now come to the other great branch of a general mathematical education, namely Geometry. The same principles apply. The theoretical part should be clear-cut, rigid, short, and important. Every proposition not absolutely necessary to exhibit the main connection of ideas should be cut out, but the great fundamental ideas should be all there. No omission of concepts, such as those of Similarity and Proportion. We must remember that, owing to the aid

rendered by the visual presence of a figure, Geometry is a field of unequalled excellence for the exercise of the deductive faculties of reasoning. Then, of course, there follows Geometrical Drawing, with its training for the hand and eye.

But, like Algebra, Geometry and Geometrical Drawing must be extended beyond the mere circle of geometrical ideas. In an industrial neighbourhood, machinery and workshop practice form the appropriate extension. For example, in the London Polytechnics this has been achieved with conspicuous success. For many secondary schools I suggest that surveying and maps are the natural applications. In particular, plane-table surveying should lead pupils to a vivid apprehension of the immediate application of geometric truths. Simple drawing apparatus, a surveyor's chain, and a surveyor's compass, should enable the pupils to rise from the survey and mensuration of a field to the construction of the map of a small district. The best education is to be found in gaining the utmost information from the simplest apparatus. The provision of elaborate instruments is greatly to be deprecated. To have constructed the map of a small district, to have considered its roads, its contours, its geology, its climate, its relation to other districts, the effects on the status of its inhabitants, will teach more history and geography than any knowledge of Perkin Warbeck or of Behren's Straits. I mean not a nebulous lecture on the subject, but a serious investigation in which the real facts are definitely ascertained by the aid of accurate theoretical knowledge. A typical mathematical problem should be: Survey such and such a field, draw a plan of it to such and such a scale, and find the area. It would be quite a good procedure to impart the necessary geometrical propositions without their proofs. Then, concurrently in the same term, the proofs of the propositions would be learnt while the survey was being made.

Fortunately, the specialist side of education presents an easier problem than does the provision of a general culture. For this there are many reasons. One is that many of the principles of procedure to be observed are the same in both cases, and it is unnecessary to recapitulate. Another reason is that specialist training takes place—or should take place—at a more advanced stage of the pupil's course, and thus there is easier material to work upon. But undoubtedly the chief reason is that the specialist study is normally a study of peculiar

interest to the student. He is studying it because, for some reason, he wants to know it. This makes all the difference. The general culture is designed to foster an activity of mind; the specialist course utilises this activity. But it does not do to lay too much stress on these neat antitheses. As we have already seen, in the general course foci of special interest will arise; and similarly in the special study, the external connections of the subject drag thought outwards.

Again, there is not one course of study which merely gives general culture, and another which gives special knowledge. The subjects pursued for the sake of a general education are special subjects specially studied; and, on the other hand, one of the ways of encouraging general mental activity is to foster a special devotion. You may not divide the seamless coat of learning. What education has to impart is an intimate sense for the power of ideas, for the beauty of ideas, and for the structure of ideas, together with a particular body of knowledge which has peculiar reference to the life of the being possessing it.

The appreciation of the structure of ideas is that side of a cultured mind which can only grow under the influence of a special study. I mean that eye for the whole chess-board, for the bearing of one set of ideas on another. Nothing but a special study can give any appreciation for the exact formulation of general ideas, for their relations when formulated, for their service in the comprehension of life. A mind so disciplined should be both more abstract and more concrete. It has been trained in the comprehension of abstract thought and in the analysis of facts.

Finally, there should grow the most austere of all mental qualities; I mean the sense for style. It is an æsthetic sense, based on admiration for the direct attainment of a foreseen end, simply and without waste. Style in art, style in literature, style in science, style in logic, style in practical execution have fundamentally the same æsthetic qualities, namely, attainment and restraint. The love of a subject in itself and for itself, where it is not the sleepy pleasure of pacing a mental quarter-deck, is the love of style as manifested in that study.

Here we are brought back to the position from which we started, the utility of education. Style, in its finest sense, is the last acquirement of the educated mind; it is also the most useful. It pervades the whole being. The administrator with a sense for style hates waste;

the engineer with a sense for style economises his material; the artisan with a sense for style prefers good work. Style is the ultimate morality of mind.

But above style, and above knowledge, there is something, a vague shape like fate above the Greek gods. That something is Power. Style is the fashioning of power, the restraining of power. But, after all, the power of attainment of the desired end is fundamental. The first thing is to get there. Do not bother about your style, but solve your problem, justify the ways of God to man, administer your province, or do whatever else is set before you.

Where, then, does style help? In this, with style the end is attained without side issues, without raising undesirable inflammations. With style you attain your end and nothing but your end. With style the effect of your activity is calculable, and foresight is the last gift of gods to men. With style your power is increased, for your mind is not distracted with irrelevancies, and you are more likely to attain your object. Now style is the exclusive privilege of the expert. Whoever heard of the style of an amateur painter, of the style of an amateur poet? Style is always the product of specialist study, the peculiar contribution of specialism to culture.

English education in its present phase suffers from a lack of definite aim, and from an external machinery which kills its vitality. Hitherto in this address I have been considering the aims which should govern education. In this respect England halts between two opinions. It has not decided whether to produce amateurs or experts. The profound change in the world which the nineteenth century has produced is that the growth of knowledge has given foresight. The amateur is essentially a man with appreciation and with immense versatility in mastering a given routine. But he lacks the foresight which comes from special knowledge. The object of this address is to suggest how to produce the expert without loss of the essential virtues of the amateur. The machinery of our secondary education is rigid where it should be yielding, and lax where it should be rigid. Every school is bound on pain of extinction to train its boys for a small set of definite examinations. No headmaster has a free hand to develop his general education or his specialist studies in accordance with the opportunities of his school, which are created by its staff, its environment, its class of boys, and its endowments. I sug-

gest that no system of external tests which aims primarily at examining individual scholars can result in anything but educational waste.

Primarily it is the schools and not the scholars which should be inspected. Each school should grant its own leaving certificates, based on its own curriculum. The standards of these schools should be sampled and corrected. But the first requisite for educational reform is the school as a unit, with its approved curriculum based on its own needs, and evolved by its own staff. If we fail to secure that, we simply fall from one formalism into another, from one dung-hill of inert ideas into another.

In stating that the school is the true educational unit in any national system for the safeguarding of efficiency, I have conceived the alternative system as being the external examination of the individual scholar. But every Scylla is faced by its Charybdis—or, in more homely language, there is a ditch on both sides of the road. It will be equally fatal to education if we fall into the hands of a supervising department which is under the impression that it can divide all schools into two or three rigid categories, each type being forced to adopt a rigid curriculum. When I say that the school is the educational unit, I mean exactly what I say, no larger unit, no smaller unit. Each school must have the claim to be considered in relation to its special circumstances. The classifying of schools for some purposes is necessary. But no absolutely rigid curriculum, not modified by its own staff, should be permissible. Exactly the same principles apply, with the proper modifications, to universities and to technical colleges.

When one considers in its length and in its breadth the importance of this question of the education of a nation's young, the broken lives, the defeated hopes, the national failures, which result from the frivolous inertia with which it is treated, it is difficult to restrain within oneself a savage rage. In the conditions of modern life the rule is absolute, the race which does not value trained intelligence is doomed. Not all your heroism, not all your social charm, not all your wit, not all your victories on land or at sea, can move back the finger of fate. To-day we maintain ourselves. To-morrow science will have moved forward yet one more step, and there will be no appeal from the judgment which will then be pronounced on the uneducated.

We can be content with no less than the old summary of educational ideal which has been current at any time from the dawn of our civilisation. The essence of education is that it be religious.

Pray, what is religious education?

A religious education is an education which inculcates duty and reverence. Duty arises from our potential control over the course of events. Where attainable knowledge could have changed the issue, ignorance has the guilt of vice. And the foundation of reverence is this perception, that the present holds within itself the complete sum of existence, backwards and forwards, that whole amplitude of time, which is eternity.

CHAPTER IV *TECHNICAL EDUCATION AND ITS RELATION TO SCIENCE AND LITERATURE*

The subject of this address is Technical Education. I wish to examine its essential nature and also its relation to a liberal education. Such an inquiry may help us to realise the conditions for the successful working of a national system of technical training. It is also a very burning question among mathematical teachers; for mathematics is included in most technological courses.

Now it is unpractical to plunge into such a discussion without framing in our own minds the best ideal towards which we desire to work, however modestly we may frame our hopes as to the result which in the near future is likely to be achieved.

People are shy of ideals; and accordingly we find a formulation of the ideal state of mankind placed by a modern dramatist * in the mouth of a mad priest: 'In my dreams it is a country where the State is the Church and the Church the people: three in one and one in three. It is a commonwealth in which work is play and play is life: three in one and one in three. It is a temple in which the priest is the worshipper and the worshipper the worshipped: three in one and one in three. It is a godhead in which all life is human and all humanity divine: three in one and one in three. It is, in short, the dream of a madman.'

* Cf. Bernard Shaw, *John Bull's Other Island.*

Now the part of this speech to which I would direct attention is embodied in the phrase, 'It is a commonwealth in which work is play and play is life.' This is the ideal of technical education. It sounds very mystical when we confront it with the actual facts, the toiling millions, tired, discontented, mentally indifferent, and then the employers—I am not undertaking a social analysis, but I shall carry you with me when I admit that the present facts of society are a long way off this ideal. Furthermore, we are agreed that an employer who conducted his workshop on the principle that 'work should be play' would be ruined in a week.

The curse that has been laid on humanity, in fable and in fact, is, that by the sweat of its brow shall it live. But reason and moral intuition have seen in this curse the foundation for advance. The early Benedictine monks rejoiced in their labours because they conceived themselves as thereby made fellow-workers with Christ.

Stripped of its theological trappings, the essential idea remains, that work should be transfused with intellectual and moral vision and thereby turned into a joy, triumphing over its weariness and its pain. Each of us will re-state this abstract formulation in a more concrete shape in accordance with his private outlook. State it how you like, so long as you do not lose the main point in your details. However you phrase it, it remains the sole real hope of toiling humanity; and it is in the hands of technical teachers, and of those who control their spheres of activity, so to mould the nation that daily it may pass to its labours in the spirit of the monks of old.

The immediate need of the nation is a large supply of skilled workmen, of men with inventive genius, and of employers alert in the development of new ideas.

There is one—and only one—way to obtain these admirable results. It is by producing workmen, men of science, and employers who enjoy their work. View the matter practically in the light of our knowledge of average human nature. Is it likely that a tired, bored workman, however skilful his hands, will produce a large output of first-class work? He will limit his production, will scamp his work, and be an adept at evading inspection; he will be slow in adapting himself to new methods; he will be a focus of discontent, full of unpractical revolutionary ideas, controlled by no sympathetic apprehension of the real working of trade conditions. If, in the troubled times which may be before us, you wish appreciably to increase the chance

of some savage upheaval, introduce widespread technical education and ignore the Benedictine ideal. Society will then get what it deserves.

Again, inventive genius requires pleasurable mental activity as a condition for its vigorous exercise. 'Necessity is the mother of invention' is a silly proverb. 'Necessity is the mother of futile dodges' is much nearer to the truth. The basis of the growth of modern invention is science, and science is almost wholly the outgrowth of pleasurable intellectual curiosity.

The third class are the employers, who are to be enterprising. Now it is to be observed that it is the successful employers who are the important people to get at, the men with business connections all over the world, men who are already rich. No doubt there will always be a continuous process of rise and fall of businesses. But it is futile to expect flourishing trade, if in the mass the successful houses of business are suffering from atrophy. Now if these men conceive their businesses as merely indifferent means for acquiring other disconnected opportunities of life, they have no spur to alertness. They are already doing very well, the mere momentum of their present business engagements will carry them on for their time. They are not at all likely to bother themselves with the doubtful chances of new methods. Their real soul is in the other side of their life. Desire for money will produce hard-fistedness and not enterprise. There is much more hope for humanity from manufacturers who enjoy their work than from those who continue in irksome business with the object of founding hospitals.

Finally, there can be no prospect of industrial peace so long as masters and men in the mass conceive themselves as engaged in a soulless operation of extracting money from the public. Enlarged views of the work performed, and of the communal service thereby rendered, can be the only basis on which to found sympathetic co-operation.

The conclusion to be drawn from this discussion is, that alike for masters and for men a technical or technological education, which is to have any chance of satisfying the practical needs of the nation, must be conceived in a liberal spirit as a real intellectual enlightenment in regard to principles applied and services rendered. In such an educational geometry and poetry are as essential as turning lathes.

The mythical figure of Plato may stand for modern liberal educa-

tion as does that of St. Benedict for technical education. We need not entangle ourselves in the qualifications necessary for a balanced representation of the actual thoughts of the actual men. They are used here as symbolic figures typical of antithetical notions. We consider Plato in the light of the type of culture he now inspires.

In its essence a liberal education is an education for thought and for æsthetic appreciation. It proceeds by imparting a knowledge of the masterpieces of thought, of imaginative literature, and of art. The action which it contemplates is command. It is an aristocratic education implying leisure. This Platonic ideal has rendered imperishable services to European civilisation. It has encouraged art, it has fostered that spirit of disinterested curiosity which is the origin of science, it has maintained the dignity of mind in the face of material force, a dignity which claims freedom of thought. Plato did not, like St. Benedict, bother himself to be a fellow-worker with his slaves; but he must rank among the emancipators of mankind. His type of culture is the peculiar inspiration of the liberal aristocrat, the class from which Europe derives what ordered liberty it now possesses. For centuries, from Pope Nicholas V to the school of the Jesuits, and from the Jesuits to the modern headmasters of English public schools, this educational ideal has had the strenuous support of the clergy.

For certain people it is a very good education. It suits their type of mind and the circumstances amid which their life is passed. But more has been claimed for it than this. All education has been judged adequate or defective according to its approximation to this sole type.

The essence of the type is a large discursive knowledge of the best literature. The ideal product of the type is the man who is acquainted with the best that has been written. He will have acquired the chief languages, he will have considered the histories of the rise and fall of nations, the poetic expression of human feeling, and have read the great dramas and novels. He will also be well grounded in the chief philosophies, and have attentively read those philosophic authors who are distinguished for lucidity of style.

It is obvious that, except at the close of a long life, he will not have much time for anything else if any approximation is to be made to the fulfilment of this programme. One is reminded of the calculation in a dialogue of Lucian that, before a man could be justified in

practising any one of the current ethical systems, he should have spent a hundred and fifty years in examining their credentials.

Such ideals are not for human beings. What is meant by a liberal culture is nothing so ambitious as a full acquaintance with the varied literary expression of civilised mankind from Asia to Europe, and from Europe to America. A small selection only is required; but then, as we are told, it is a selection of the very best. I have my doubts of a selection which includes Xenophon and omits Confucius, but then I have read through neither in the original. The ambitious programme of a liberal education really shrinks to a study of some fragments of literature included in a couple of important languages.

But the expression of the human spirit is not confined to literature. There are the other arts, and there are the sciences. Also education must pass beyond the passive reception of the ideas of others. Powers of initiative must be strengthened. Unfortunately initiative does not mean just one acquirement—there is initiative in thought, initiative in action, and the imaginative initiative of art; and these three categories require many subdivisions.

The field of acquirement is large, and the individual so fleeting and so fragmentary: classical scholars, scientists, headmasters are alike ignoramuses.

There is a curious illusion that a more complete culture was possible when there was less to know. Surely the only gain was, that it was more possible to remain unconscious of ignorance. It cannot have been a gain to Plato to have read neither Shakespeare, nor Newton, nor Darwin. The achievements of a liberal education have in recent times not been worsened. The change is that its pretensions have been found out.

My point is, that no course of study can claim any position of ideal completeness. Nor are the omitted factors of subordinate importance. The insistence in the Platonic culture on disinterested intellectual appreciation is a psychological error. Action and our implication in the transition of events amid the inevitable bond of cause to effect are fundamental. An education which strives to divorce intellectual or æsthetic life from these fundamental facts carries with it the decadence of civilisation. Essentially culture should be for action, and its effect should be to divest labour from the associations of aimless toil. Art exists that we may know the deliverances of our senses as good. It heightens the sense-world.

Disinterested scientific curiosity is a passion for an ordered intellectual vision of the connection of events. But the goal of such curiosity is the marriage of action to thought. This essential intervention of action even in abstract science is often overlooked. No man of science wants merely to know. He acquires knowledge to appease his passion for discovery. He does not discover in order to know, he knows in order to discover. The pleasure which art and science can give to toil is the enjoyment which arises from successfully directed intention. Also it is the same pleasure which is yielded to the scientist and to the artist.

The antithesis between a technical and a liberal education is fallacious. There can be no adequate technical education which is not liberal, and no liberal education which is not technical: that is, no education which does not impart both technique and intellectual vision. In simpler language, education should turn out the pupil with something he knows well and something he can do well. This intimate union of practice and theory aids both. The intellect does not work best in a vacuum. The stimulation of creative impulse requires, especially in the case of a child, the quick transition to practice. Geometry and mechanics, followed by workshop practice, gain that reality without which mathematics is verbiage.

There are three main methods which are required in a national system of education, namely, the literary curriculum, the scientific curriculum, the technical curriculum. But each of these curricula should include the other two. What I mean is, that every form of education should give the pupil a technique, a science, an assortment of general ideas, and æsthetic appreciation, and that each of these sides of his training should be illuminated by the others. Lack of time, even for the most favoured pupil, makes it impossible to develop fully each curriculum. Always there must be a dominant emphasis. The most direct æsthetic training naturally falls in the technical curriculum in those cases when the training is that requisite for some art or artistic craft. But it is of high importance in both a literary and a scientific education.

The educational method of the literary curriculum is the study of language, that is, the study of our most habitual method of conveying to others our states of mind. The technique which should be acquired is the technique of verbal expression, the science is the study of the structure of language and the analysis of the relations of language to

the states of mind conveyed. Furthermore, the subtle relations of language to feeling, and the high development of the sense organs to which written and spoken words appeal, lead to keen æsthetic appreciations being aroused by the successful employment of language. Finally, the wisdom of the world is preserved in the masterpieces of linguistic composition.

This curriculum has the merit of homogeneity. All its various parts are co-ordinated and play into each other's hands. We can hardly be surprised that such a curriculum, when once broadly established, should have claimed the position of the sole perfect type of education. Its defect is unduly to emphasise the importance of language. Indeed the varied importance of verbal expression is so overwhelming that its sober estimation is difficult. Recent generations have been witnessing the retreat of literature, and of literary forms of expression, from their position of unique importance in intellectual life. In order truly to become a servant and a minister of nature something more is required than literary aptitudes.

A scientific education is primarily a training in the art of observing natural phenomena, and in the knowledge and deduction of laws concerning the sequence of such phenomena. But here, as in the case of a liberal education, we are met by the limitations imposed by shortness of time. There are many types of natural phenomena, and to each type there corresponds a science with its peculiar modes of observation, and its peculiar types of thought employed in the deduction of laws. A study of science in general is impossible in education, all that can be achieved is the study of two or three allied sciences. Hence the charge of narrow specialism urged against any education which is primarily scientific. It is obvious that the charge is apt to be well-founded; and it is worth considering how, within the limits of a scientific education and to the advantage of such an education, the danger can be avoided.

Such a discussion requires the consideration of technical education. A technical education is in the main a training in the art of utilising knowledge for the manufacture of material products. Such a training emphasises manual skill, and the co-ordinated action of hand and eye, and judgment in the control of the process of construction. But judgment necessitates knowledge of those natural processes of which the manufacture is the utilisation. Thus somewhere in technical training an education in scientific knowledge is required. If you minimise

the scientific side, you will confine it to the scientific experts; if you maximise it, you will impart it in some measure to the men, and—what is of no less importance—to the directors and managers of the businesses.

Technical education is not necessarily allied exclusively to science on its mental side. It may be an education for an artist or for apprentices to an artistic craft. In that case æsthetic appreciation will have to be cultivated in connection with it.

An evil side of the Platonic culture has been its total neglect of technical education as an ingredient in the complete development of ideal human beings. This neglect has arisen from two disastrous antitheses, namely, that between mind and body, and that between thought and action. I will here interject, solely to avoid criticism, that I am well aware that the Greeks highly valued physical beauty and physical activity. They had, however, that perverted sense of values which is the nemesis of slave-owning.

I lay it down as an educational axiom that in teaching you will come to grief as soon as you forget that your pupils have bodies. This is exactly the mistake of the post-renaissance Platonic curriculum. But nature can be kept at bay by no pitchfolk; so in English education, being expelled from the classroom, she returned with a cap and bells in the form of all-conquering athleticism.

The connections between intellectual activity and the body, though diffused in every bodily feeling, are focussed in the eyes, the ears, the voice, and the hands. There is a co-ordination of senses and thought, and also a reciprocal influence between brain activity and material creative activity. In this reaction the hands are peculiarly important. It is a moot point whether the human hand created the human brain, or the brain created the hand. Certainly the connection is intimate and reciprocal. Such deep-seated relations are not widely atrophied by a few hundred years of disuse in exceptional families.

The disuse of hand-craft is a contributory cause to the brain-lethargy of aristocracies, which is only mitigated by sport where the concurrent brain-activity is reduced to a minimum and the hand-craft lacks subtlety. The necessity for constant writing and vocal exposition is some slight stimulus to the thought-power of the professional classes. Great readers, who exclude other activities, are not distinguished by subtlety of brain. They tend to be timid con-

ventional thinkers. No doubt this is partly due to their excessive knowledge outrunning their powers of thought; but it is partly due to the lack of brain-stimulus from the productive activities of hand or voice.

In estimating the importance of technical education we must rise above the exclusive association of learning with book-learning. First-hand knowledge is the ultimate basis of intellectual life. To a large extent book-learning conveys second-hand information, and as such can never rise to the importance of immediate practice. Our goal is to see the immediate events of our lives as instances of our general ideas. What the learned world tends to offer is one second-hand scrap of information illustrating ideas derived from another second-hand scrap of information. The second-handedness of the learned world is the secret of its mediocrity. It is tame because it has never been scared by facts. The main importance of Francis Bacon's influence does not lie in any peculiar theory of inductive reasoning which he happened to express, but in the revolt against second-hand information of which he was a leader.

The peculiar merit of a scientific education should be, that it bases thought upon first-hand observation; and the corresponding merit of a technical education is, that it follows our deep natural instinct to translate thought into manual skill, and manual activity into thought.

The thought which science evokes is logical thought. Now logic is of two kinds: the logic of discovery and the logic of the discovered.

The logic of discovery consists in the weighing of probabilities, in discarding details deemed to be irrelevant, in divining the general rules according to which events occur, and in testing hypotheses by devising suitable experiments. This is inductive logic.

The logic of the discovered is the deduction of the special events which, under certain circumstances, would happen in obedience to the assumed laws of nature. Thus when the laws are discovered or assumed, their utilisation entirely depends on deductive logic. Without deductive logic science would be entirely useless. It is merely a barren game to ascend from the particular to the general, unless afterwards we can reverse the process and descend from the general to the particular, ascending and descending like the angels on Jacob's ladder. When Newton had divined the law of gravitation he at once proceeded to calculate the earth's attractions on an apple at its

surface and on the moon. We may note in passing that inductive logic would be impossible without deductive logic. Thus Newton's calculations were an essential step in his inductive verification of the great law.

Now mathematics is nothing else than the more complicated parts of the art of deductive reasoning, especially where it concerns number, quantity, and space.

In the teaching of science, the art of thought should be taught: namely, the art of forming clear conceptions applying to first-hand experience, the art of divining the general truths which apply, the art of testing divinations, and the art of utilising general truths by reasoning to more particular cases of some peculiar importance. Furthermore, a power of scientific exposition is necessary, so that the relevant issues from a confused mass of ideas can be stated clearly, with due emphasis on important points.

By the time a science, or a small group of sciences, has been taught thus amply, with due regard to the general art of thought, we have gone a long way towards correcting the specialism of science. The worst of a scientific education based, as necessarily must be the case, on one or two particular branches of science, is that the teachers under the influence of the examination system are apt merely to stuff their pupils with the narrow results of these special sciences. It is essential that the generality of the method be continually brought to light and contrasted with the speciality of the particular application. A man who only knows his own science, as a routine peculiar to that science, does not even know that. He has no fertility of thought, no power of quickly seizing the bearing of alien ideas. He will discover nothing, and be stupid in practical applications.

This exhibition of the general in the particular is extremely difficult to effect, especially in the case of younger pupils. The art of education is never easy. To surmount its difficulties, especially those of elementary education, is a task worthy of the highest genius. It is the training of human souls.

Mathematics, well taught, should be the most powerful instrument in gradually implanting this generality of ideas. The essence of mathematics is perpetually to be discarding more special ideas in favour of more general ideas, and special methods in favour of general methods. We express the conditions of a special problem in the form of an equation, but that equation will serve for a hundred other

problems, scattered through diverse sciences. The general reasoning is always the powerful reasoning, because deductive cogency is the property of abstract form.

Here, again, we must be careful. We shall ruin mathematical education if we use it merely to impress general truths. The general ideas are the means of connecting particular results. After all, it is the concrete special cases which are important. Thus in the handling of mathematics in your results you cannot be too concrete, and in your methods you cannot be too general. The essential course of reasoning is to generalise what is particular, and then to particularize what is general. Without generality there is no reasoning, without concreteness there is no importance.

Concreteness is the strength of technical education. I would remind you that truths which lack the highest generality are not necessarily concrete facts. For example, $x + y = y + x$ is an algebraic truth more general than $2 + 2 = 4$. But 'two and two make four' is itself a highly general proposition lacking any element of concreteness. To obtain a concrete proposition immediate intuition of a truth concerning particular objects is requisite; for example, 'these two apples and those apples together make four apples' is a concrete proposition, if you have direct perception or immediate memory of the apples.

In order to obtain the full realisation of truths as applying, and not as empty formulæ, there is no alternative to technical education. Mere passive observation is not sufficient. In creation only is there vivid insight into the properties of the object thereby produced. If you want to understand anything, make it yourself, is a sound rule. Your faculties will be alive, your thoughts gain vividness by an immediate translation into acts. Your ideas gain that reality which comes from seeing the limits of their application.

In elementary education this doctrine has long been put into practice. Young children are taught to familiarise themselves with shapes and colours by simple manual operations of cutting out and of sorting. But good though this is, it is not quite what I mean. That is practical experience before you think, experience antecedent to thought in order to create ideas, a very excellent discipline. But technical education should be much more than that: it is creative experience while you think, experience which realises your thought, experience which teaches you to co-ordinate act and thought, experi-

ence leading you to associate thought with foresight and foresight with achievement. Technical education gives theory, and a shrewd insight as to where theory fails.

A technical education is not to be conceived as a maimed alternative to the perfect Platonic culture: namely, as a defective training unfortunately made necessary by cramped conditions of life. No human being can attain to anything but fragmentary knowledge and a fragmentary training of his capacities. There are, however, three main roads along which we can proceed with good hope of advancing towards the best balance of intellect and character: these are the way of literary culture, the way of scientific culture, the way of technical culture. No one of these methods can be exclusively followed without grave loss of intellectual activity and of character. But a mere mechanical mixture of the three curricula will produce bad results in the shape of scraps of information never interconnected or utilised. We have already noted as one of the strong points of the traditional literary culture that all its parts are co-ordinated. The problem of education is to retain the dominant emphasis, whether literary, scientific, or technical, and without loss of co-ordination to infuse into each way of education something of the other two.

To make definite the problem of technical education fix attention on two ages: one thirteen, when elementary education ends; and the other seventeen, when technical education ends so far as it is compressed within a school curriculum. I am aware that for artisans in junior technical schools a three-years' course would be more usual. On the other hand, for naval officers, and for directing classes generally, a longer time can be afforded. We want to consider the principles to govern a curriculum which shall land these children at the age of seventeen in the position of having technical skill useful to the community.

Their technical manual training should start at thirteen, bearing a modest proportion to the rest of their work, and should increase in each year finally to attain to a substantial proportion. Above all things it should not be too specialised. Workshop finish and workshop dodges, adapted to one particular job, should be taught in the commercial workshop, and should form no essential part of the school course. A properly trained worker would pick them up in no time. In all education the main cause of failure is staleness. Technical education is doomed if we conceive it as a system for catching

children young and for giving them one highly specialised manual aptitude. The nation has need of a fluidity of labour, not merely from place to place, but also within reasonable limits of allied aptitudes, from one special type of work to another special type. I know that here I am on delicate ground, and I am not claiming that men while they are specialising on one sort of work should spasmodically be set to other kinds. That is a question of trade organisation with which educationalists have no concern. I am only asserting the principles that training should be broader than the ultimate specialisation, and that the resulting power of adaptation to varying demands is advantageous to the workers, to the employers, and to the nation.

In considering the intellectual side of the curriculum we must be guided by the principle of the co-ordination of studies. In general, the intellectual studies most immediately related to manual training will be some branches of science. More than one branch will, in fact, be concerned; and even if that be not the case, it is impossible to narrow down scientific study to a single thin line of thought. It is possible, however, provided that we do not press the classification too far, roughly to classify technical pursuits according to the dominant science involved. We thus find a sixfold division, namely, (1) Geometrical techniques, (2) Mechanical techniques, (3) Physical techniques, (4) Chemical techniques, (5) Biological techniques, (6) Techniques of commerce and of social service.

By this division, it is meant that apart from auxiliary sciences some particular science requires emphasis in the training for most occupations. We can, for example, reckon carpentry, ironmongery, and many artistic crafts among geometrical techniques. Similarly agriculture is a biological technique. Probably cookery, if it includes food catering, would fall midway between biological, physical, and chemical sciences, though of this I am not sure.

The sciences associated with commerce and social service would be partly algebra, including arithmetic and statistics, and partly geography and history. But this section is somewhat heterogeneous in its scientific affinities. Anyhow the exact way in which technical pursuits are classified in relation to science is a detail. The essential point is, that with some thought it is possible to find scientific courses which illuminate most occupations. Furthermore, the problem is well understood, and has been brilliantly solved in many of the schools of technology and junior technical schools throughout the country.

In passing from science to literature, in our review of the intellectual elements of technical education, we note that many studies hover between the two: for example, history and geography. They are both of them very essential in education, provided that they are the right history and the right geography. Also books giving descriptive accounts of general results, and trains of thought in various sciences fall in the same category. Such books should be partly historical and partly expository of the main ideas which have finally arisen. Their value in education depends on their quality as mental stimulants. They must not be inflated with gas on the wonders of science, and must be informed with a broad outlook.

It is unfortunate that the literary element in education has rarely been considered apart from grammatical study. The historical reason is, that when the modern Platonic curriculum was being formed Latin and Greek were the sole keys which rendered great literature accessible. But there is no necessary connection between literature and grammar. The great age of Greek literature was already past before the arrival of the grammarians of Alexandria. Of all types of men to-day existing, classical scholars are the most remote from the Greeks of the Periclean times.

Mere literary knowledge is of slight importance. The only thing that matters is, how it is known. The facts related are nothing. Literature only exists to express and develop that imaginative world which is our life, the kingdom which is within us. It follows that the literary side of a technical education should consist in an effort to make the pupils enjoy literature. It does not matter what they know, but the enjoyment is vital. The great English Universities, under whose direct authority school-children are examined in plays of Shakespeare, to the certain destruction of their enjoyment, should be prosecuted for soul murder.

Now there are two kinds of intellectual enjoyment: the enjoyment of creation, and the enjoyment of relaxation. They are not necessarily separated. A change of occupation may give the full tide of happiness which comes from the concurrence of both forms of pleasure. The appreciation of literature is really creation. The written word, its music, and its associations, are only the stimuli. The vision which they evoke is our own doing. No one, no genius other than our own, can make our own life live. But except for those engaged in literary occupations, literature is also a relaxation. It gives exercise to that

other side which any occupation must suppress during the working hours. Art also has the same function in life as has literature.

To obtain the pleasure of relaxation requires no help. The pleasure is merely to cease doing. Some such pure relaxation is a necessary condition of health. Its dangers are notorious, and to the greater part of the necessary relaxation nature has affixed, not enjoyment, but the oblivion of sleep. Creative enjoyment is the outcome of successful effort and requires help for its initiation. Such enjoyment is necessary for high-speed work and for original achievement.

To speed up production with unrefreshed workmen is a disastrous economic policy. Temporary success will be at the expense of the nation, which, for long years of their lives, will have to support worn-out artisans—unemployables. Equally disastrous is the alternation of spasms of effort with periods of pure relaxation. Such periods are the seed-times of degeneration, unless rigorously curtailed. The normal recreation should be change of activity, satisfying the cravings of instincts. Games afford such activity. Their disconnection emphasises the relaxation, but their excess leaves us empty.

It is here that literature and art should play an essential part in a healthily organised nation. Their services to economic production would be only second to those of sleep or of food. I am not now talking of the training of an artist, but of the use of art as a condition of healthy life. It is analogous to sunshine in the physical world.

When we have once rid our minds of the idea that knowledge is to be exacted, there is no especial difficulty or expense involved in helping the growth of artistic enjoyment. All school-children could be sent at regular intervals to neighbouring theatres where suitable plays could be subsidised. Similarly for concerts and cinema films. Pictures are more doubtful in their popular attraction; but interesting representations of scenes or ideas which the children have read about would probably appeal. The pupils themselves should be encouraged in artistic efforts. Above all the art of reading aloud should be cultivated. The Roger de Coverley essays of Addison are perfect examples of readable prose.

Art and literature have not merely an indirect effect on the main energies of life. Directly, they give vision. The world spreads wide beyond the deliverances of material sense, with subtleties of reaction and with pulses of emotion. Vision is the necessary antecedent to control and to direction. In the contest of races which in its final

issues will be decided in the workshops and not on the battlefield, the victory will belong to those who are masters of stores of trained nervous energy, working under conditions favourable to growth. One such essential condition is Art.

If there had been time, there are other things which I should like to have said: for example, to advocate the inclusion of one foreign language in all education. From direct observation I know this to be possible for artisan children. But enough has been put before you to make plain the principles with which we should undertake national education.

In conclusion, I recur to the thought of the Benedictines, who saved for mankind the vanishing civilisation of the ancient world by linking together knowledge, labour, and moral energy. Our danger is to conceive practical affairs as the kingdom of evil, in which success is only possible by the extrusion of ideal aims. I believe that such a conception is a fallacy directly negatived by practical experience. In education this error takes the form of a mean view of technical training. Our forefathers in the dark ages saved themselves by embodying high ideals in great organisations. It is our task, without servile imitation, boldly to exercise our creative energies.

CHAPTER V *THE PLACE OF CLASSICS IN EDUCATION*

The future of classics in this country is not going mainly to be decided by the joy of classics to a finished scholar, and by the utility of scholarly training for scholarly avocations. The pleasure and the discipline of character to be derived from an education based mainly on classical literature and classical philosophy have been demonstrated by centuries of experience. The danger to classical learning does not arise because classical scholars now love classics less than their predecessors. It arises in this way. In the past classics reigned throughout the whole sphere of higher education. There were no rivals; and accordingly all students were steeped in classics throughout their school life, and its domination at the universities was only challenged by the narrow discipline of mathematics. There were many consequences to this state of things. There was a large demand for

classical scholars for the mere purposes of tuition; there was a classical tone in all learned walks of life, so that aptitude for classics was a synonym for ability; and finally every boy who gave the slightest promise in that direction cultivated his natural or acquired interest in classical learning. All this is gone, and gone for ever. Humpty Dumpty was a good egg so long as he was on the top of the wall, but you can never set him up again. There are now other disciplines each involving topics of wide-spread interest, with complex relationships, and exhibiting in their development the noblest feats of genius in its stretch of imagination and its philosophic intuition. Almost every walk of life is now a learned profession, and demands one or more of these disciplines as the substratum for its technical skill. Life is short, and the plastic period when the brain is apt for acquirement is still shorter. Accordingly, even if all children were fitted for it, it is absolutely impossible to maintain a system of education in which a complete training as a classical scholar is the necessary preliminary to the acquirement of other intellectual disciplines. As a member of the Prime Minister's Committee on the Place of Classics in Education it was my misfortune to listen to much ineffectual wailing from witnesses on the mercenary tendencies of modern parents. I do not believe that the modern parent of any class is more mercenary than his predecessors. When classics was the road to advancement, classics was the popular subject for study. Opportunity has now shifted its location, and classics is in danger. Was it not Aristotle who said that a good income was a desirable adjunct to an intellectual life? I wonder how Aristotle, as a parent, would have struck a headmaster of one of our great public schools. From my slight knowledge of Aristotle, I suspect that there would have been an argument, and that Aristotle would have got the best of it. I have been endeavouring to appreciate at its full value the danger which besets classics in the educational curriculum. The conclusion that I draw is that the future of classics will be decided during the next few years in the secondary schools of this country. Within a generation the great public schools will have to follow suit, whether they like it or not.

The situation is dominated by the fact that in the future ninety per cent. of the pupils who leave school at the age of eighteen will never again read a classical book in the original. In the case of pupils leaving at an earlier age, the estimate of ninety per cent. may be changed to one of ninety-nine per cent. I have heard and read many

a beautiful exposition of the value of classics to the scholar who reads Plato and Virgil in his armchair. But these people will never read classics either in their armchairs or in any other situation. We have got to produce a defence of classics which applies to this ninety per cent. of the pupils. If classics is swept out of the curriculum for this section, the remaining ten per cent. will soon vanish. No school will have the staff to teach them. The problem is urgent.

It would, however, be a great mistake to conclude that classics is faced with a hostile opinion either in the learned professions or from leaders of industry who have devoted attention to the relation between education and efficiency. The last discussion, public or private, on this subject at which I have been present was a short and vigorous one at one of the leading committees of a great modern university. The three representatives of the Faculty of Science energetically urged the importance of classics on the ground of its value as a preliminary discipline for scientists. I mention this incident because in my experience it is typical.

We must remember that the whole problem of intellectual education is controlled by lack of time. If Methuselah was not a well-educated man, it was his own fault or that of his teachers. But our task is to deal with five years of secondary-school life. Classics can only be defended on the ground that within that period, and sharing that period with other subjects, it can produce a necessary enrichment of intellectual character more quickly than any alternative discipline directed to the same object.

In classics we endeavour by a thorough study of language to develop the mind in the regions of logic, philosophy, history and of æsthetic apprehension of literary beauty. The learning of the languages—Latin or Greek—is a subsidiary means for the furtherance of this ulterior object. When the object has been obtained, the languages can be dropped unless opportunity and choice lead to their further pursuit. There are certain minds, and among them some of the best, for which the analysis of language is not the avenue of approach to the goal of culture. For these a butterfly or a steam-engine has a wider range of significance than a Latin sentence. This is especially the case where there is a touch of genius arising from vivid apprehensions stimulating originality of thought. The assigned verbal sentence almost always says the wrong thing for such people, and confuses them by its trivial irrelevance.

But on the whole the normal avenue is the analysis of language. It represents the greatest common measure for the pupils, and by far the most manageable job for the teachers.

At this point I must cross-question myself. My other self asks me, Why do you not teach the children logic, if you want them to learn that subject? Wouldn't that be the obvious procedure? I answer in the words of a great man who to our infinite loss has recently died, Sanderson, the late headmaster of Oundle. His phrase was, They learn by contact. The meaning to be attached to this saying goes to the root of the true practice of education. It must start from the particular fact, concrete and definite for individual apprehension, and must gradually evolve towards the general idea. The devil to be avoided is the cramming of general statements which have no reference to individual personal experiences.

Now apply this principle to the determination of the best method to help a child towards a philosophical analysis of thought. I will put it in more homely style, What is the best way to make a child clear-headed in its thoughts and its statements? The general statements of a logic book have no reference to anything the child has ever heard of. They belong to the grown-up stage of education at—or not far from—the university. You must begin with the analysis of familiar English sentences. But this grammatical procedure, if prolonged beyond its elementary stages, is horribly dry. Furthermore, it has the disadvantage that it only analyses so far as the English language analyses. It does nothing to throw light upon the complex significance of English phrases, and words, and habits of mental procedure. Your next step is to teach the child a foreign language. Here you gain an enormous advantage. You get away from the nauseating formal drill for the drill's sake. The analysis is now automatic, while the pupil's attention is directed to expressing his wants in the language, or to understanding someone who is speaking to him, or to making out what an author has written. Every language embodies a definite type of mentality, and two languages necessarily display to the pupil some contrast between their two types. Common sense dictates that you start with French as early as possible in the child's life. If you are wealthy, you will provide a French nursery-governess. Less fortunate children will start French in a secondary school about the age of twelve. The direct method is probably used, by which the child is immersed in French throughout the lesson and is taught to

think in French without the intervention of English between the French words and their significations. Even an average child will get on well, and soon acquires the power of handling and understanding simple French sentences. As I have said before, the gain is enormous; and, in addition, a useful instrument for after life is acquired. The sense for language grows, a sense which is the subconscious appreciation of language as an instrument of definite structure.

It is exactly now that the initiation of Latin is the best stimulus for mental expansion. The elements of Latin exhibit a peculiarly plain concrete case of language as a structure. Provided that your mind has grown to the level of that idea, the fact stares you in the face. You can miss it over English and French. Good English of a simple kind will go straight into slipshod French, and conversely good French will go into slipshod English. The difference between the slipshod French of the literal translation and the good French, which ought to have been written, is often rather subtle for that stage of mental growth, and is not always easy to explain. Both languages have the same common modernity of expression. But in the case of English and Latin the contrast of structure is obvious, and yet not so wide as to form an insuperable difficulty.

According to the testimony of schoolmasters, Latin is rather a popular subject; I know that as a schoolboy I enjoyed it myself. I believe that this popularity is due to the sense of enlightenment that accompanies its study. You know that you are finding out something. The words somehow stick in the sentences in a different way to what they do either in English or French, with odd queer differences of connotation. Of course in a way Latin is a more barbaric language than English. It is one step nearer to the sentence as the unanalysed unit.

This brings me to my next point. In my catalogue of the gifts of Latin I placed philosophy between logic and history. In this connection, that is its true place. The philosophic instinct which Latin evokes, hovers between the two and enriches both. The analysis of thought involved in translation, English to Latin or Latin to English, imposes that type of experience which is the necessary introduction to philosophic logic. If in after life your job is to think, render thanks to Providence which ordained that, for five years of your youth, you did a Latin prose once a week and daily construed some Latin author. The introduction to any subject is the process of learning by

contact. To that majority of people for whom language is the readiest stimulus to thought-activity, the road towards enlightenment of understanding runs from simple English grammar to French, from French to Latin, and also traverses the elements of Geometry and of Algebra. I need not remind my readers that I can claim Plato's authority for the general principle which I am upholding.

From the philosophy of thought we now pass to the philosophy of history. I again recur to Sanderson's great saying, They learn by contact. How on earth is a child to learn history by contact? The original documents, charters and laws and diplomatic correspondence, are double Dutch to it. A game of football is perhaps a faint reflection of the Battle of Marathon. But that is only to say that human life in all ages and circumstances has common qualities. Furthermore, all this diplomatic and political stuff with which we cram children is a very thin view of history. What is really necessary is that we should have an instinctive grasp of the flux of outlook, and of thought, and of æsthetic and racial impulses, which have controlled the troubled history of mankind. Now the Roman Empire is the bottleneck through which the vintage of the past has passed into modern life. So far as European civilisation is concerned the key to history is a comprehension of the mentality of Rome and the work of its Empire.

In the language of Rome, embodying in literary form the outlook of Rome, we possess the simplest material, by contact with which we can gain appreciation of the tides of change in human affairs. The mere obvious relations of the languages, French and English, to Latin are in themselves a philosophy of history. Consider the contrast which English presents to French: the entire break of English with the civilised past of Britain and the slow creeping back of words and phrases of Mediterranean origin with their cargoes of civilised meaning: in French we have continuity of development, amid obvious traces of rude shock. I am not asking for pretentious abstract lectures on such points. The thing illustrates itself. An elementary knowledge of French and Latin with a mother-tongue of English imparts the requisite atmosphere of reality to the story of the racial wanderings which created our Europe. Language is the incarnation of the mentality of the race which fashioned it. Every phrase and word embodies some habitual idea of men and women as they ploughed their fields, tended their homes, and built their cities. For this reason

there are no true synonyms as between words and phrases in different languages. The whole of what I have been saying is merely an embroidery upon this single theme, and our endeavour to emphasise its critical importance. In English, French, and Latin we possess a triangle, such that one pair of vertices, English and French, exhibits a pair of diverse expressions of two chief types of modern mentality, and the relations of these vertices to the third exhibit alternative processes of derivation from the Mediterranean civilisation of the past. This is the essential triangle of literary culture, containing within itself freshness of contrast, embracing both the present and the past. It ranges through space and time. These are the grounds by which we justify the assertion, that in the acquirement of French and Latin is to be found the easiest mode of learning by contact the philosophy of logic and the philosophy of history. Apart from some such intimate experience, your analyses of thought and your histories of actions are mere sounding brasses. I am not claiming, and I do not for a moment believe, that this route of education is more than the simplest, easiest route for the majority of pupils. I am certain that there is a large minority for which the emphasis should be different. But I do believe that it is the route which can give the greatest success for the largest majority. It has also the advantage of having survived the test of experience. I believe that large modifications require to be introduced into existing practice to adapt it for present needs. But on the whole this foundation of literary education involves the best understood tradition and the largest corps of experienced scholarly teachers who can realise it in practice.

The reader has perhaps observed that I have as yet said nothing of the glories of Roman literature. Of course the teaching of Latin must proceed by the means of reading Latin literature with the pupils. This literature possesses vigorous authors who have succeeded in putting across the footlights the Roman mentality on a variety of topics, including its appreciation of Greek thought. One of the merits of Roman literature is its comparative lack of outstanding genius. There is very little aloofness about its authors, they express their race and very little which is beyond all differences of race. With the exception of Lucretius, you always feel the limitations under which they are working. Tacitus expressed the views of the Die-hards of the Roman Senate, and, blind to the achievements of Roman provincial administration, could only see that Greek freedmen were replac-

ing Roman aristocrats. The Roman Empire and the mentality which created it absorbed the genius of Romans. Very little of Roman literature will find its way into the kingdom of heaven, when the events of this world will have lost their importance. The languages of heaven will be Chinese, Greek, French, German, Italian, and English, and the blessed Saints will dwell with delight on these golden expressions of eternal life. They will be wearied with the moral fervour of Hebrew literature in its battle with a vanished evil, and with Roman authors who have mistaken the Forum for the footstool of the living God.

We do not teach Latin in the hope that Roman authors, read in the original, may be for our pupils companions through life. English literature is so much greater: it is richer, deeper, and more subtle. If your tastes are philosophic, would you abandon Bacon and Hobbes, Locke, Berkeley, Hume, and Mill for the sake of Cicero? Not unless your taste among the moderns would lead you to Martin Tupper. Perhaps you crave for reflection on the infinite variety of human existence and the reaction of character to circumstance. Would you exchange Shakespeare and the English novelists for Terence, Plautus, and the banquet of Trimalchio? Then there are our humorists, Sheridan, Dickens, and others. Did anyone ever laugh like that as he read a Latin author? Cicero was a great orator, staged amid the pomp of Empire. England also can show statesmen inspired to expound policies with imagination. I will not weary you with an extended catalogue embracing poetry and history. I simply wish to justify my scepticism as to the claim for Latin literature that it expresses with outstanding perfection the universal element in human life. It cannot laugh, and it can hardly cry.

You must not tear it from its context. It is not a literature in the sense that Greece and England have produced literatures, expressions of universal human feeling. Latin has one theme and that is Rome—Rome, the mother of Europe, and the great Babylon, the harlot whose doom is described by the writer of the Apocalypse:

'Standing afar off for the fear of her torment, saying, Alas, alas, that great city of Babylon, that mighty city! for in one hour is thy judgment come. And the merchants of the earth shall weep and mourn over her; for no man buyeth their merchandise any more:

'The merchandise of gold, and silver, and precious stones, and of pearls, and fine linen, and purple, and silk, and scarlet, and all

thyine wood, and all manner vessels of ivory, and all manner vessels of most precious wood, and of brass, and iron, and marble;

'And cinnamon, and odours, and ointments, and frankincense, and wine, and oil, and fine flour, and wheat, and beasts, and sheep, and horses, and chariots, and slaves, and souls of men.'

This is the way Roman civilisation appeared to an early Christian. But then Christianity itself is part of the outcrop of the ancient world which Rome passed on to Europe. We inherit the dual aspect of the civilisations of the eastern Mediterranean.

The function of Latin literature is its expression of Rome. When to England and France your imagination can add Rome in the background, you have laid firm the foundations of culture. The understanding of Rome leads back to that Mediterranean civilisation of which Rome was the last phase, and it automatically exhibits the geography of Europe, and the functions of seas and rivers and mountains and plains. The merit of this study in the education of youth is its concreteness, its inspiration to action, and the uniform greatness of persons, in their characters and their staging. Their aims were great, their virtues were great, and their vices were great. They had the saving merit of sinning with cart-ropes. Moral education is impossible apart from the habitual vision of greatness. If we are not great, it does not matter what we do or what is the issue. Now the sense of greatness is an immediate intuition and not the conclusion of an argument. It is permissible for youth in the agonies of religious conversion to entertain the feeling of being a worm and no man, so long as there remains the conviction of greatness sufficient to justify the eternal wrath of God. The sense of greatness is the groundwork of morals. We are at the threshold of a democratic age, and it remains to be determined whether the equality of man is to be realised on a high level or a low level. There was never a time in which it was more essential to hold before the young the vision of Rome: in itself a great drama, and with issues greater than itself. We are now already immersed in the topic of æsthetic appreciation of literary quality. It is here that the tradition of classical teaching requires most vigorous reformation for adaptation to new conditions. It is obsessed with the formation of finished classical scholars. The old tradition was remorselessly to devote the initial stages to the acquirement of the languages and then to trust to the current literary atmosphere to secure enjoyment of the literature. During the latter

part of the nineteenth century other subjects encroached on the available time. Too often the result has been merely time wasted in the failure to learn the language. I often think that the ruck of pupils from great English schools show a deplorable lack of intellectual zest, arising from this sense of failure. The school course of classics must be planned so that a definite result is clearly achieved. There has been too great a product of failures on the road to an ambitious ideal of scholarship.

In approaching every work of art we have to comport ourselves suitably in regard to two factors, scale and pace. It is not fair to the architect if you examine St. Peter's at Rome with a microscope, and the Odyssey becomes insipid if you read it at the rate of five lines a day. Now the problem before us is exactly this. We are dealing with pupils who will never know Latin well enough to read it quickly, and the vision to be illumed is of vast scale, set in the history of all time. A careful study of scale and pace, and of the correlative functions of various parts of our work, should appear to be essential. I have not succeeded in hitting upon any literature which deals with this question with reference to the psychology of the pupils. Is it a masonic secret?

I have often noticed that, if in an assembly of great scholars the topic of translations be introduced, they function as to their emotions and sentiments in exactly the same way as do decent people in the presence of a nasty sex-problem. A mathematician has no scholastic respectability to lose, so I will face the question.

It follows from the whole line of thought which I have been developing, that an exact appreciation of the meanings of Latin words, of the ways in which ideas are connected in grammatical constructions, and of the whole hang of a Latin sentence with its distribution of emphasis, forms the very backbone of the merits which I ascribe to the study of Latin. Accordingly any woolly vagueness of teaching, slurring over the niceties of language, defeats the whole ideal which I have set before you. The use of a translation to enable the pupils to get away from the Latin as quickly as possible, or to avoid the stretch of mind in grappling with construction, is erroneous. Exactness, definiteness, and independent power of analysis are among the main prizes of the whole study.

But we are still confronted with the inexorable problem of pace, and with the short four or five years of the whole course. Every poem

is meant to be read within certain limits of time. The contrasts, and the images, and the transition of moods must correspond with the sway of rhythms in the human spirit. These have their periods, which refuse to be stretched beyond certain limits. You may take the noblest poetry in the world, and, if you stumble through it at snail's pace, it collapses from a work of art into a rubbish heap. Think of the child's mind as he pores over his work: he reads 'as when,' then follows a pause with a reference to the dictionary, then he goes on—'an eagle,' then another reference to the dictionary, followed by a period of wonderment over the construction, and so on, and so on. Is that going to help him to the vision of Rome? Surely, surely, common sense dictates that you procure the best literary translation you can, the one which best preserves the charm and vigour of the original, and that you read it aloud at the right pace, and append such comments as will elucidate the comprehension. The attack on the Latin will then be fortified by the sense that it enshrines a living work of art.

But someone objects that a translation is woefully inferior to the original. Of course it is, that is why the boy has to master the Latin original. When the original has been mastered, it can be given its proper pace. I plead for an initial sense of the unity of the whole, to be given by a translation at the right pace, and for a final appreciation of the full value of the whole to be given by the original at the right pace. Wordsworth talks of men of science who 'murder to dissect.' In the past, classical scholars have been veritable assassins compared to them. The sense of beauty is eager and vehement, and should be treated with the reverence which is its due. But I go further. The total bulk of Latin literature necessary to convey the vision of Rome is much greater than the students can possibly accomplish in the original. They should read more Virgil than they can read in Latin, more Lucretius than they can read in Latin, more history than they can read in Latin, more Cicero than they can read in Latin. In the study of an author the selected portions in Latin should illumine a fuller disclosure of his whole mind, although without the force of his own words in his own language. It is, however, a grave evil if no part of an author be read in his own original words.

The difficulty of scale is largely concerned in the presentation of classical history. Everything set before the young must be rooted in

the particular and the individual. Yet we want to illustrate the general characters of whole periods. We must make students learn by contact. We can exhibit the modes of life by visual representations. There are photographs of buildings, casts of statues, and pictures from vases or frescoes illustrating religious myths or domestic scenes. In this way we can compare Rome with the preceding civilisation of the eastern Mediterranean, and with the succeeding period of the Middle Ages. It is essential to get into the children's minds how men altered, in their appearance, their dwellings, their technology, their art, and their religious beliefs. We must imitate the procedure of the zoologists who have the whole of animal creation on their hands. They teach by demonstrating typical examples. We must do likewise, to exhibit the position of Rome in history.

The life of man is founded on Technology, Science, Art and Religion. All four are inter-connected and issue from his total mentality. But there are particular intimacies between Science and Technology, and between Art and Religion. No social organisation can be understood without reference to these four underlying factors. A modern steam-engine does the work of a thousand slaves in the ancient world. Slave-raiding was the key to much of the ancient imperialism. A modern printing-press is an essential adjunct to a modern democracy. The key to modern mentality is the continued advance of science with the consequential shift of ideas and progress of technology. In the ancient world Mesopotamia and Egypt were made possible by irrigation. But the Roman Empire existed by virtue of the grandest application of technology that the world had hitherto seen: its roads, its bridges, its aqueducts, its tunnels, its sewers, its vast buildings, its organised merchant navies, its military science, its metallurgy, and its agriculture. This was the secret of the extension and the unity of Roman civilisation. I have often wondered why Roman engineers did not invent the steam-engine. They might have done it at any time, and then how different would have been the history of the world. I ascribe it to the fact that they lived in a warm climate and had not introduced tea and coffee. In the eighteenth century thousands of men sat by fires and watched their kettles boil. We all know of course that Hiero of Alexandria invented some slight anticipation. All that was wanted was that the Roman engineers should have been impressed with the motive force of steam by the humble process of watching their kettles.

The history of mankind has yet to be set in its proper relation to the gathering momentum of technological advance. Within the last hundred years, a developed science has wedded itself to a developed technology and a new epoch has opened.

Similarly about a thousand years before Christ the first great literary epoch commenced when the art of writing was finally popularised. In its earlier dim origins the art had been used for traditional hieratic formulæ and for the formal purposes of governmental record and chronicle. It is a great mistake to think that in the past the full sweep of a new invention has ever been anticipated at its first introduction. It is not even so at the present day, when we are all trained to meditate on the possibilities of new ideas. But in the past, with its different direction of thought, novelty slowly ate its way into the social system. Accordingly writing, as a stimulus to the preservation of individual novelty of thought, was but slowly grasped on the borders of the eastern Mediterranean. When the realisation of its possibilities was complete, in the hands of the Greeks and the Hebrews, civilisation took a new turn; though the general influence of Hebrew mentality was delayed for a thousand years till the advent of Christianity. But it was now that their prophets were recording their inward thoughts, when Greek civilisation was beginning to take shape.

What I want to illustrate is that in the large scale treatment of history necessary for the background and the foreground of the vision of Rome, the consecutive chronicle of political events on the scale traditional to our histories absolutely vanishes. Even verbal explanations partly go into the background. We must utilise models, and pictures, and diagrams, and charts to exhibit typical examples of the growth of technology and its impact on the current modes of life. In the same way art, in its curious fusion with utility and with religion, both expresses the actual inward life of imagination and changes it by its very expression. The children can see the art of previous epochs in models and pictures, and sometimes the very objects in museums. The treatment of the history of the past must not start with generalised statements, but with concrete examples exhibiting the slow succession of period to period, and of mode of life to mode of life, and of race to race.

The same concreteness of treatment must apply when we come to the literary civilisations of the eastern Mediterranean. When you

come to think of it, the whole claim for the importance of classics rests on the basis that there is no substitute for first-hand knowledge. In so far as Greece and Rome are the founders of European civilisation, a knowledge of history means above all things a first-hand knowledge of the thoughts of Greeks and Romans. Accordingly, to put the vision of Rome into its proper setting, I urge that the pupils should read at first hand some few examples of Greek literature. Of course it must be in translation. But I prefer a translation of what a Greek actually said, to any talk about the Greeks written by an Englishman, however well he has done it. Books about Greece should come after some direct knowledge of Greece.

The sort of reading I mean is a verse translation of the Odyssey, some Herodotus, some choruses of plays translated by Gilbert Murray, some lives of Plutarch, especially the part about Archimedes in the life of Marcellus, and the definitions and axioms and one or two propositions from Euclid's Elements in the exact scholarly translation of Heath. In all this, just enough explanation is wanted to give the mental environment of the authors. The marvellous position of Rome in relation to Europe comes from the fact that it has transmitted to us a double inheritance. It received the Hebrew religious thought, and has passed on to Europe its fusion with Greek civilisation. Rome itself stands for the impress of organization and unity upon diverse fermenting elements. Roman Law embodies the secret of Roman greatness in its Stoic respect for intimate rights of human nature within an iron framework of empire. Europe is always flying apart because of the diverse explosive character of its inheritance, and coming together because it can never shake off that impress of unity it has received from Rome. The history of Europe is the history of Rome curbing the Hebrew and the Greek, with their various impulses of religion, and of science, and of art, and of quest for material comfort, and of lust of domination, which are all at daggers drawn with each other. The vision of Rome is the vision of the unity of civilisation.

CHAPTER VII *UNIVERSITIES AND THEIR FUNCTION*

I

The expansion of universities is one marked feature of the social life in the present age. All countries have shared in this movement, but more especially America, which thereby occupies a position of honor. It is, however, possible to be overwhelmed even by the gifts of good fortune; and this growth of universities, in number of institutions, in size, and in internal complexity of organization, discloses some danger of destroying the very sources of their usefulness, in the absence of a widespread understanding of the primary functions which universities should perform in the service of a nation. These remarks, as to the necessity for reconsideration of the function of universities, apply to all the more developed countries. They are only more especially applicable to America, because this country has taken the lead in a development which, under wise guidance, may prove to be one of the most fortunate forward steps which civilisation has yet taken.

This article will only deal with the most general principles, though the special problems of the various departments in any university are, of course, innumerable. But generalities require illustration, and for this purpose I choose the business school of a university. This choice is dictated by the fact that business schools represent one of the newer developments of university activity. They are also more particularly relevant to the dominant social activities of modern nations, and for that reason are good examples of the way in which the national life should be affected by the activities of its universities. Also at Harvard, where I have the honour to hold office, the new foundation of a business school on a scale amounting to magnificence has just reached its completion.

There is a certain novelty in the provision of such a school of training, on this scale of magnitude, in one of the few leading universities of the world. It marks the culmination of a movement which for many years past has introduced analogous departments throughout American universities. This is a new fact in the university world; and it alone would justify some general reflections upon the

purpose of a university education, and upon the proved importance of that purpose for the welfare of the social organism.

The novelty of business schools must not be exaggerated. At no time have universities been restricted to pure abstract learning. The University of Salerno in Italy, the earliest of European universities, was devoted to medicine. In England, at Cambridge, in the year 1316, a college was founded for the special purpose of providing 'clerks for the King's service.' Universities have trained clergy, medical men, lawyers, engineers. Business is now a highly intellectualized vocation, so it well fits into the series. There is, however, this novelty: the curriculum suitable for a business school, and the various modes of activity of such a school, are still in the experimental stage. Hence the peculiar importance of recurrence to general principles in connection with the moulding of these schools. It would, however, be an act of presumption on my part if I were to enter upon any consideration of details, or even upon types of policy affecting the balance of the whole training. Upon such questions I have no special knowledge, and therefore have no word of advice.

II

The universities are schools of education, and schools of research. But the primary reason for their existence is not to be found either in the mere knowledge conveyed to the students or in the mere opportunities for research afforded to the members of the faculty.

Both these functions could be performed at a cheaper rate, apart from these very expensive institutions. Books are cheap, and the system of apprenticeship is well understood. So far as the mere imparting of information is concerned, no university has had any justification for existence since the popularisation of printing in the fifteenth century. Yet the chief impetus to the foundation of universities came after that date, and in more recent times has even increased.

The justification for a university is that it preserves the connection between knowledge and the zest of life, by uniting the young and the old in the imaginative consideration of learning. The university imparts information, but it imparts it imaginatively. At least, this is the function which it should perform for society. A university which fails in this respect has no reason for existence. This atmosphere of excitement, arising from imaginative consideration, transforms knowledge. A fact is no longer a bare fact: it is invested with

all its possibilities. It is no longer a burden on the memory: it is energising as the poet of our dreams, and as the architect of our purposes.

Imagination is not to be divorced from the facts: it is a way of illuminating the facts. It works by eliciting the general principles which apply to the facts, as they exist, and then by an intellectual survey of alternative possibilities which are consistent with those principles. It enables men to construct an intellectual vision of a new world, and it preserves the zest of life by the suggestion of satisfying purposes.

Youth is imaginative, and if the imagination be strengthened by discipline this energy of imagination can in great measure be preserved through life. The tragedy of the world is that those who are imaginative have but slight experience, and those who are experienced have feeble imaginations. Fools act on imagination without knowledge; pedants act on knowledge without imagination. The task of a university is to weld together imagination and experience.

The initial discipline of imagination in its period of youthful vigour requires that there be no responsibility for immediate action. The habit of unbiased thought, whereby the ideal variety of exemplifications is discerned in its derivation from general principles, cannot be acquired when there is the daily task of preserving a concrete organisation. You must be free to think rightly and wrongly, and free to appreciate the variousness of the universe undisturbed by its perils.

These reflections upon the general functions of a university can be at once translated in terms of the particular functions of a business school. We need not flinch from the assertion that the main function of such a school is to produce men with a greater zest for business. It is a libel upon human nature to conceive that zest for life is the product of pedestrian purposes directed toward the narrow routine of material comforts. Mankind by its pioneering instinct, and in a hundred other ways, proclaims the falsehood of that lie.

In the modern complex social organism, the adventure of life cannot be disjoined from intellectual adventure. Amid simpler circumstances, the pioneer can follow the urge of his instinct, directed toward the scene of his vision from the mountain top. But in the complex organisations of modern business the intellectual adventure of analysis, and of imaginative reconstruction, must precede any suc-

cessful reorganisation. In a simpler world, business relations were simpler, being based on the immediate contact of man with man and on immediate confrontation with all relevant material circumstances. To-day business organisation requires an imaginative grasp of the psychologies of populations engaged in differing modes of occupation; of populations scattered through cities, through mountains, through plains; of populations on the ocean, and of populations in mines, and of populations in forests. It requires an imaginative grasp of conditions in the tropics, and of conditions in temperate zones. It requires an imaginative grasp of the interlocking interests of great organisations, and of the reactions of the whole complex to any change in one of its elements. It requires an imaginative understanding of laws of political economy, not merely in the abstract, but also with the power to construe them in terms of the particular circumstances of a concrete business. It requires some knowledge of the habits of government, and of the variations of those habits under diverse conditions. It requires an imaginative vision of the binding forces of any human organization, a sympathetic vision of the limits of human nature and of the conditions which evoke loyalty of service. It requires some knowledge of the laws of health, and of the laws of fatigue, and of the conditions for sustained reliability. It requires an imaginative understanding of the social effects of the conditions of factories. It requires a sufficient conception of the rôle of applied science in modern society. It requires that discipline of character which can say 'yes' and 'no' to other men, not by reason of blind obstinacy, but with firmness derived from a conscious evaluation of relevant alternatives.

The universities have trained the intellectual pioneers of our civilisation—the priests, the lawyers, the statesmen, the doctors, the men of science, and the men of letters. They have been the home of those ideals which lead men to confront the confusion of their present times. The Pilgrim Fathers left England to found a state of society according to the ideals of their religious faith; and one of their earlier acts was the foundation of Harvard University in Cambridge, named after that ancient mother of ideals in England, to which so many of them owed their training. The conduct of business now requires intellectual imagination of the same type as that which in former times has mainly passed into those other occupations; and

the universities are the organisations which have supplied this type of mentality for the service of the progress of the European races.

In early mediæval history the origin of universities was obscure and almost unnoticed. They were a gradual and natural growth. But their existence is the reason for the sustained, rapid progressiveness of European life in so many fields of activity. By their agency the adventure of action met the adventure of thought. It would not have been possible antecedently to have divined that such organisations would have been successful. Even now, amid the imperfections of all things human, it is sometimes difficult to understand how they succeed in their work. Of course there is much failure in the work of universities. But, if we take a broad view of history, their success has been remarkable and almost uniform. The cultural histories of Italy, of France, of Germany, of Holland, of Scotland, of England, of the United States, bear witness to the influence of universities. By 'cultural history' I am not chiefly thinking of the lives of scholars; I mean the energising of the lives of those men who gave to France, to Germany, and to other countries that impress of types of human achievement which, by their addition to the zest of life, form the foundation of our patriotism. We love to be members of a society which can do those things.

There is one great difficulty which hampers all the higher types of human endeavor. In modern times this difficulty has even increased in its possibilities for evil. In any large organisation the younger men, who are novices, must be set to jobs which consist in carrying out fixed duties in obedience to orders. No president of a large corporation meets his youngest employee at his office door with the offer of the most responsible job which the work of that corporation includes. The young men are set to work at a fixed routine, and only occasionally even see the president as he passes in and out of the building. Such work is a great discipline. It imparts knowledge, and it produces reliability of character; also it is the only work for which the young men, in that novice stage, are fit, and it is the work for which they are hired. There can be no criticism of the custom, but there may be an unfortunate effect—prolonged routine work dulls the imagination.

The result is that qualities essential at a later stage of a career are apt to be stamped out in an earlier stage. This is only an instance

of the more general fact, that necessary technical excellence can only be acquired by a training which is apt to damage those energies of mind which should direct the technical skill. This is the key fact in education, and the reason for most of its difficulties.

The way in which a university should function in the preparation for an intellectual career, such as modern business or one of the older professions, is by promoting the imaginative consideration of the various general principles underlying that career. Its students thus pass into their period of technical apprenticeship with their imaginations already practised in connecting details with general principles. The routine then receives its meaning, and also illuminates the principles which give it that meaning. Hence, instead of a drudgery issuing in a blind rule of thumb, the properly trained man has some hope of obtaining an imagination disciplined by detailed facts and by necessary habits.

Thus the proper function of a university is the imaginative acquisition of knowledge. Apart from this importance of the imagination, there is no reason why business men, and other professional men, should not pick up their facts bit by bit as they want them for particular occasions. A university is imaginative or it is nothing—at least nothing useful.

III

Imagination is a contagious disease. It cannot be measured by the yard, or weighed by the pound, and then delivered to the students by members of the faculty. It can only be communicated by a faculty whose members themselves wear their learning with imagination. In saying this, I am only repeating one of the oldest of observations. More than two thousand years ago the ancient symbolised learning by a torch passing from hand to hand down the generations. That lighted torch is the imagination of which I speak. The whole art in the organisation of a university is the provision of a faculty whose learning is lighted up with imagination. This is the problem of problems in university education; and unless we are careful the recent vast extension of universities in number of students and in variety of activities—of which we are so justly proud—will fail in producing its proper results, by the mishandling of this problem.

The combination of imagination and learning normally requires some leisure, freedom from restraint, freedom from harassing worry,

some variety of experiences, and the stimulation of other minds diverse in opinion and diverse in equipment. Also there is required the excitement of curiosity, and the self-confidence derived from pride in the achievements of the surrounding society in procuring the advance of knowledge. Imagination cannot be acquired once and for all, and then kept indefinitely in an ice box to be produced periodically in stated quantities. The learned and imaginative life is a way of living, and is not an article of commerce.

It is in respect to the provision and utilisation of these conditions for an efficient faculty that the two functions of education and research meet together in a university. Do you want your teachers to be imaginative? Then encourage them to research. Do you want your researchers to be imaginative? Then bring them into intellectual sympathy with the young at the most eager, imaginative period of life, when intellects are just entering upon their mature discipline. Make your researchers explain themselves to active minds, plastic and with the world before them; make your young students crown their period of intellectual acquisition by some contact with minds gifted with experience of intellectual adventure. Education is discipline for the adventure of life; research is intellectual adventure; and the universities should be homes of adventure shared in common by young and old. For successful education there must always be a certain freshness in the knowledge dealt with. It must either be new in itself or it must be invested with some novelty of application to the new world of new times. Knowledge does not keep any better than fish. You may be dealing with knowledge of the old species, with some old truth; but somehow or other it must come to the students, as it were, just drawn out of the sea and with the freshness of its immediate importance.

It is the function of the scholar to evoke into life wisdom and beauty which, apart from his magic, would remain lost in the past. A progressive society depends upon its inclusion of three groups—scholars, discoverers, inventors. Its progress also depends upon the fact that its educated masses are composed of members each with a tinge of scholarship, a tinge of discovery, and a tinge of invention. I am here using the term 'discovery' to mean the progress of knowledge in respect to truths of some high generality, and the term 'invention' to mean the progress of knowledge in respect to the application of general truths in particular ways subservient to present

needs. It is evident that these three groups merge into each other, and also that men engaged in practical affairs are properly to be called inventors so far as they contribute to the progress of society. But any one individual has his own limitation of function, and his own peculiar needs. What is important for a nation is that there shall be a very close relation between all types of its progressive elements, so that the study may influence the market place, and the market place the study. Universities are the chief agencies for this fusion of progressive activities into an effective instrument of progress. Of course they are not the only agencies, but it is a fact that to-day the progressive nations are those in which universities flourish.

It must not be supposed that the output of a university in the form of original ideas is solely to be measured by printed papers and books labeled with the names of their authors. Mankind is as individual in its mode of output as in the substance of its thoughts. For some of the most fertile minds composition in writing, or in a form reducible to writing, seems to be an impossibility. In every faculty you will find that some of the more brilliant teachers are not among those who publish. Their originality requires for its expression direct intercourse with their pupils in the form of lectures, or of personal discussion. Such men exercise an immense influence; and yet, after the generation of their pupils has passed away, they sleep among the innumerable unthanked benefactors of humanity. Fortunately, one of them is immortal—Socrates.

Thus it would be the greatest mistake to estimate the value of each member of a faculty by the printed work signed with his name. There is at the present day some tendency to fall into this error; and an emphatic protest is necessary against an attitude on the part of authorities which is damaging to efficiency and unjust to unselfish zeal.

But, when all such allowances have been made, one good test for the general efficiency of a faculty is that as a whole it shall be producing in published form its quota of contributions of thought. Such a quota is to be estimated in weight of thought, and not in number of words.

This survey shows that the management of a university faculty has no analogy to that of a business organisation. The public opinion of the faculty, and a common zeal for the purposes of the university, form the only effective safeguards for the high level of university

work. The faculty should be a band of scholars, stimulating each other, and freely determining their various activities. You can secure certain formal requirements, that lectures are given at stated times and that instructors and students are in attendance. But the heart of the matter lies beyond all regulation.

The question of justice to the teachers has very little to do with the case. It is perfectly just to hire a man to perform any legal services under any legal conditions as to times and salary. No one need accept the post unless he so desires.

The sole question is, What sort of conditions will produce the type of faculty which will run a successful university? The danger is that it is quite easy to produce a faculty entirely unfit—a faculty of very efficient pedants and dullards. The general public will only detect the difference after the university has stunted the promise of youth for scores of years.

The modern university system in the great democratic countries will only be successful if the ultimate authorities exercise singular restraint, so as to remember that universities cannot be dealt with according to the rules and policies which apply to the familiar business corporations. Business schools are no exception to this law of university life. There is really nothing to add to what the presidents of many American universities have recently said in public on this topic. But whether the effective portion of the general public, in America or other countries, will follow their advice appears to be doubtful. The whole point of a university, on its educational side, is to bring the young under the intellectual influence of a band of imaginative scholars. There can be no escape from proper attention to the conditions which—as experience has shown—will produce such a band.

IV

The two premier universities of Europe, in age and in dignity, are the University of Paris and the University of Oxford. I will speak of my own country because I know it best. The University of Oxford may have sinned in many ways. But, for all her deficiencies, she has throughout the ages preserved one supreme merit, beside which all failures in detail are as dust in the balance: for century after century, throughout the long course of her existence, she has produced bands of scholars who treated learning imaginatively. For

that service alone, no one who loves culture can think of her without emotion.

But it is quite unnecessary for me to cross the ocean for my examples. The author of the Declaration of Independence, Mr. Jefferson, has some claim to be the greatest American. The perfection of his various achievements certainly places him among the few great men of all ages. He founded a university, and devoted one side of his complex genius to placing that university amid every circumstance which could stimulate the imagination—beauty of buildings, of situation, and every other stimulation of equipment and organization.

There are many other universities in America which can point my moral, but my final example shall be Harvard—the representative university of the Puritan movement. The New England Puritans of the seventeenth and eighteenth centuries were the most intensely imaginative people, restrained in their outward expression, and fearful of symbolism by physical beauty, but, as it were, racked with the intensity of spiritual truths intellectually imagined. The Puritan faculties of those centuries must have been imaginative indeed, and they produced great men whose names have gone round the world. In later times Puritanism softened, and, in the golden age of literary New England, Emerson, Lowell, and Longfellow set their mark upon Harvard. The modern scientific age then gradually supervenes, and again in William James we find the typical imaginative scholar.

To-day business comes to Harvard; and the gift which the University has to offer is the old one of imagination, the lighted torch which passes from hand to hand. It is a dangerous gift, which has started many a conflagration. If we are timid as to that danger, the proper course is to shut down our universities. Imagination is a gift which has often been associated with great commercial peoples—with Greece, with Florence, with Venice, with the learning of Holland, and with the poetry of England. Commerce and imagination thrive together. It is a gift which all must pray for their country who desire for it that abiding greatness achieved by Athens:—

> Her citizens, imperial spirits,
> Rule the present from the past.

For American education no smaller ideal can suffice.

CHAPTER VIII *THE ORGANISATION OF THOUGHT*

The subject of this address is the organisation of thought, a topic evidently capable of many diverse modes of treatment. I intend more particularly to give some account of that department of logical science with which some of my own studies have been connected. But I am anxious, if I can succeed in so doing, to handle this account so as to exhibit the relation with certain considerations which underlie general scientific activities.

It is no accident that an age of science has developed into an age of organisation. Organised thought is the basis of organised action. Organisation is the adjustment of diverse elements so that their mutual relations may exhibit some predetermined quality. An epic poem is a triumph of organisation, that is to say, it is a triumph in the unlikely event of its being a good epic poem. It is the successful organisation of multitudinous sounds of words, associations of words, pictorial memories of diverse events and feelings ordinarily occurring in life, combined with a special narrative of great events: the whole so disposed as to excite emotions which, as defined by Milton, are simple, sensuous, and passionate. The number of successful epic poems is commensurate, or rather, is inversely commensurate, with the obvious difficulty of the task of organisation.

Science is the organisation of thought. But the example of the epic poem warns us that science is not any organisation of thought. It is an organisation of a certain definite type which we will endeavour to determine.

Science is a river with two sources, the practical source and the theoretical source. The practical source is the desire to direct our actions to achieve predetermined ends. For example, the British nation, fighting for justice, turns to science, which teaches it the importance of compounds of nitrogen. The theoretical source is the desire to understand. Now I am going to emphasise the importance of theory in science. But to avoid misconception I most emphatically state that I do not consider one source as in any sense nobler than the other, or intrinsically more interesting. I cannot see why it is nobler to strive to understand than to busy oneself with the right ordering of one's actions. Both have their bad side; there are evil

ends directing actions, and there are ignoble curiosities of the understanding.

The importance, even in practice, of the theoretical side of science arises from the fact that action must be immediate, and takes place under circumstances which are excessively complicated. If we wait for the necessities of action before we commence to arrange our ideas, in peace we shall have lost our trade, and in war we shall have lost the battle. Success in practice depends on theorists who, led by other motives of exploration, have been there before, and by some good chance have hit upon the relevant ideas. By a theorist I do not mean a man who is up in the clouds, but a man whose motive for thought is the desire to formulate correctly the rules according to which events occur. A successful theorist should be excessively interested in immediate events, otherwise he is not at all likely to formulate correctly anything about them. Of course, both sources of science exist in all men.

Now, what is this thought organisation which we call science? The first aspect of modern science which struck thoughtful observers was its inductive character. The nature of induction, its importance, and the rules of inductive logic have been considered by a long series of thinkers, especially English thinkers: Bacon, Herschel, J. S. Mill, Venn, Jevons, and others. I am not going to plunge into an analysis of the process of induction. Induction is the machinery and not the product, and it is the product which I want to consider. When we understand the product we shall be in a stronger position to improve the machinery.

First, there is one point which it is necessary to emphasize. There is a tendency in analysing scientific processes to assume a given assemblage of concepts applying to nature, and to imagine that the discovery of laws of nature consists in selecting by means of inductive logic some one out of a definite set of possible alternative relations which may hold between the things in nature answering to these obvious concepts. In a sense this assumption is fairly correct, especially in regard to the earlier stages of science. Mankind found itself in possession of certain concepts respecting nature—for example, the concept of fairly permanent material bodies—and proceeded to determine laws which related the corresponding percepts in nature. But the formulation of laws changed the concepts, sometimes gently by an added precision, sometimes violently. At first this

process was not much noticed, or at least was felt to be a process curbed within narrow bounds, not touching fundamental ideas. At the stage where we now are, the formulation of the concepts can be seen to be as important as the formulation of the empirical laws connecting the events in the universe as thus conceived by us. For example, the concepts of life, of heredity, of a material body, of a molecule, of an atom, of an electron, of energy, of space, of time, of quantity, and of number. I am not dogmatising about the best way of getting such ideas straight. Certainly it will only be done by those who have devoted themselves to a special study of the facts in question. Success is never absolute, and progress in the right direction is the result of a slow, gradual process of continual comparison of ideas with facts. The criterion of success is that we should be able to formulate empirical laws, that is, statements of relations, connecting the various parts of the universe as thus conceived, laws with the property that we can interpret the actual events of our lives as being our fragmentary knowledge of this conceived interrelated whole.

But, for the purpose of science, what is the actual world? Has science to wait for the termination of the metaphysical debate till it can determine its own subject-matter? I suggest that science has a much more homely starting-ground. Its task is the discovery of the relations which exist within that flux of perceptions, sensations, and emotions which forms our experience of life. The panorama yielded by sight, sound, taste, smell, touch, and by more inchoate sensible feelings, is the sole field of activity. It is in this way that science is the thought organisation of experience. The most obvious aspect of this field of actual experience is its disorderly character. It is for each person a *continuum,* fragmentary, and with elements not clearly differentiated. The comparison of the sensible experiences of diverse people brings its own difficulties. I insist on the radically untidy, ill-adjusted character of the fields of actual experience from which science starts. To grasp this fundamental truth is the first step in wisdom, when constructing a philosophy of science. This fact is concealed by the influence of language, moulded by science, which foists on us exact concepts as though they represented the immediate deliverances of experience. The result is, that we imagine that we have immediate experience of a world of perfectly defined objects implicated in perfectly defined events which, as known to us by the direct deliverance of our senses, happen at exact instants of time, in a space

formed by exact points, without parts and without magnitude: the neat, trim, tidy, exact world which is the goal of scientific thought.

My contention is, that this world is a world of ideas, and that its internal relations are relations between abstract concepts, and that the elucidation of the precise connection between this world and the feelings of actual experience is the fundamental question of scientific philosophy. The question which I am inviting you to consider is this: How does exact thought apply to the fragmentary, vague *continua* of experience? I am not saying that it does not apply: quite the contrary. But I want to know how it applies. The solution I am asking for is not a phrase, however brilliant, but a solid branch of science, constructed with slow patience, showing in detail how the correspondence is effected.

The first great steps in the organisation of thought were due exclusively to the practical source of scientific activity, without any admixture of theoretical impulse. Their slow accomplishment was the cause and also the effect of the gradual evolution of moderately rational beings. I mean the formation of the concepts of definite material objects, of the determinate lapse of time, of simultaneity, of recurrence, of definite relative position, and of analogous fundamental ideas, according to which the flux of our experience is mentally arranged for handy reference: in fact, the whole apparatus of common-sense thought. Consider in your mind some definite chair. The concept of that chair is simply the concept of all the interrelated experiences connected with that chair—namely, of the experience of the folk who made it, of the folk who sold it, of the folk who have seen it or used it, of the man who is now experiencing a comfortable sense of support, combined with our expectations of an analogous future, terminated finally by a different set of experiences when the chair collapses and becomes firewood. The formation of that type of concept was a tremendous job, and zoologists and geologists tell us that it took many tens of millions of years. I can well believe it.

I now emphasise two points. In the first place, science is rooted in what I have just called the whole apparatus of common-sense thought. That is the *datum* from which it starts, and to which it must recur. We may speculate, if it amuses us, on other beings in other planets who have arranged analogous experiences according to an entirely different conceptual code—namely, who have directed their

chief attention to different relations between their various experiences. But the task is too complex, too gigantic, to be revised in its main outlines. You may polish up common sense, you may contradict in detail, you may surprise it. But ultimately your whole task is to satisfy it.

In the second place, neither common sense nor science can proceed with their task of thought organisation without departing in some respect from the strict consideration of what is actual in experience. Think again of the chair. Among the experiences upon which its concept is based, I included our expectations of its future history. I should have gone further and included our imagination of all the possible experiences which in ordinary language we should call perceptions of the chair which might have occurred. This is a difficult question, and I do not see my way through it. But, at present, in the construction of a theory of space and of time there seem insuperable difficulties if we refuse to admit ideal experiences.

This imaginative perception of experiences, which, if they occurred, would be coherent with our actual experiences, seems fundamental in our lives. It is neither wholly arbitrary, nor yet fully determined. It is a vague background which is only made in part definite by isolated activities of thought. Consider, for example, our thoughts of the unseen flora of Brazil.

Ideal experiences are closely connected with our imaginative reproduction of the actual experiences of other people, and also with our almost inevitable conception of ourselves as receiving our impressions from an external complex reality beyond ourselves. It may be that an adequate analysis of every source and every type of experience yields demonstrative proof of such a reality and of its nature. Indeed, it is hardly to be doubted that this is the case. The precise elucidation of this question is the problem of metaphysics. One of the points which I am urging in this address is, that the basis of science does not depend on the assumption of any of the conclusions of metaphysics; but that both science and metaphysics start from the same given groundwork of immediate experience, and in the main proceed in opposite directions on their diverse tasks.

For example, metaphysics inquires how our perceptions of the chair relate us to some true reality. Science gathers up these perceptions into a determinate class, adds to them ideal perceptions of analogous sort, which under assignable circumstances would be ob-

tained, and this single concept of that set of perceptions is all that science needs.

My immediate problem is to inquire into the nature of the texture of science. Science is essentially logical. The nexus between its concepts is a logical nexus, and the grounds for its detailed assertions are logical grounds. King James said, 'No bishops, no king.' With greater confidence we can say, 'No logic, no science.' The reason for the instinctive dislike which most men of science feel towards the recognition of this truth is, I think, the barren failure of logical theory during the past three or four centuries. We may trace this failure back to the worship of authority, which in some respects increased in the learned world at the time of the Renaissance. Mankind then changed its authority, and this fact temporally acted as an emancipation. But the main fact, and we can find complaints * of it at the very commencement of the modern movement, was the establishment of a reverential attitude towards any statement made by a classical author. Scholars became commentators on truths too fragile to bear translation. A science which hesitates to forget its founders is lost. To this hesitation I ascribe the barrenness of logic. Another reason for distrust of logical theory and of mathematics is the belief that deductive reasoning can give you nothing new. Your conclusions are contained in your premises, which by hypothesis are known to you.

In the first place this last condemnation of logic neglects the fragmentary, disconnected character of human knowledge. To know one premise on Monday, and another premise on Tuesday, is useless to you on Wednesday. Science is a permanent record of premises, deductions, and conclusions, verified all along the line by its correspondence with facts. Secondly, it is untrue that when we know the premises we also know the conclusions. In arithmetic, for example, mankind are not calculating boys. Any theory which proves that they are conversant with the consequences of their assumptions must be wrong. We can imagine beings who possess such insight. But we are not such creatures. Both these answers are, I think, true and relevant. But they are not satisfactory. They are too much in the nature of bludgeons, too external. We want something more explanatory of the very real difficulty which the question suggests. In fact, the true

* E.g., in 1551 by Italian schoolmen; cf. Sarpi's *History of the Council of Trent,* under that date.

answer is embedded in the discussion of our main problem of the relation of logic to natural science.

It will be necessary to sketch in broad outline some relevant features of modern logic. In doing so I shall try to avoid the profound general discussions and the minute technical classifications which occupy the main part of traditional logic. It is characteristic of a science in its earlier stages—and logic has become fossilised in such a stage—to be both ambitiously profound in its aims and trivial in its handling of details.

We can discern four departments of logical theory. By an analogy which is not so very remote I will call these departments or sections the arithmetic section, the algebraic section, the section of general-function theory, the analytical section. I do not mean that arithmetic arises in the first section, algebra in the second section, and so on; but the names are suggestive of certain qualities of thought in each section which are reminiscent of analogous qualities in arithmetic, in algebra, in the general theory of a mathematical function, and in the mathematical analysis of the properties of particular functions.

The first section—namely, the arithmetic stage—deals with the relations of definite propositions to each other, just as arithmetic deals with definite numbers. Consider any definite proposition; call it '*p*.' We conceive that there is always another proposition which is the direct contradictory to '*p*'; call it 'not-*p*.' When we have got two propositions, *p* and *q*, we can form derivative propositions from them, and from their contradictories. We can say, 'At last one of *p* or *q* is true, and perhaps both.' Let us call this proposition '*p* or *q*.' I may mention as an aside that one of the greatest living philosophers has stated that this use of the word 'or'—namely, '*p* or *q*' in the sense that either or both may be true—makes him despair of exact expression. We must brave his wrath, which is unintelligible to me.

We have thus got hold of four new propositions, namely, '*p* or *q*,' and 'not-*p* or *q*,' and '*p* or not-*q*,' and 'not-*p* or not-*q*.' Call these the set of disjunctive derivatives. There are, so far, in all eight propositions, *p*, not-*p*, *q*, not-*q*, and the four disjunctive derivatives. Any pair of these eight propositions can be taken, and substituted for *p* and *q* in the foregoing treatment. Thus each pair yields eight propositions, some of which may have been obtained before. By proceeding in this way we arrive at an unending set of propositions of growing complexity, ultimately derived from the two original propositions

p or q. Of course, only a few are important. Similarly we can start from three propositions, p, q, r, or from four propositions, p, q, r, s, and so on. Any one of the propositions of these aggregates may be true or false. It has no other alternative. Whichever it is, true or false, call it the 'truth-value' of the proposition.

The first section of logical inquiry is to settle what we know of the truth-values of these propositions, when we know the truth-values of some of them. The inquiry, so far as it is worth while carrying it, is not very abstruse, and the best way of expressing its results is a detail which I will not now consider. This inquiry forms the arithmetic stage.

The next section of logic is the algebraic stage. Now, the difference between arithmetic and algebra is, that in arithmetic definite numbers are considered, and in algebra symbols—namely, letters—are introduced which stand for any numbers. The idea of a number is also enlarged. These letters, standing for any numbers, are called sometimes variables and sometimes parameters. Their essential characteristic is that they are undetermined, unless, indeed, the algebraic conditions which they satisfy implicitly determine them. Then they are sometimes called unknowns. An algebraic formula with letters is a blank form. It becomes a determinate arithmetic statement when definite numbers are substituted for the letters. The importance of algebra is a tribute to the study of form. Consider now the following proposition—

The specific heat of mercury is 0·033.

This is a definite proposition which, with certain limitations, is true. But the truth-value of the proposition does not immediately concern us. Instead of mercury put a mere letter which is the name of some undetermined thing: we get—

The specific heat of x is 0·033.

This is not a proposition; it has been called by Russell a propositional function. It is the logical analogy of an algebraic expression. Let us write $f(x)$ for any propositional function.

We could also generalise still further, and say,

The specific heat of x is y.

We thus get another propositional function, $F(x, y)$, of two arguments x and y, and so on for any number of arguments.

Now, consider $f(x)$. There is the range of values of x, for which $f(x)$ is a proposition, true or false. For values of x outside this range, $f(x)$ is not a proposition at all, and is neither true nor false. It may have vague suggestion for us, but it has no unit meaning of definite assertion. For example,

The specific heat of water is 0·033

is a proposition which is false; and—

The specific heat of virtue is 0·033

is, I should imagine, not a proposition at all; so that it is neither true nor false, though its component parts raise various associations in our minds. This range of values, for which $f(x)$ has sense, is called the 'type' of the argument x.

But there is also a range of values of x for which $f(x)$ is a true proposition. This is the class of those values of the argument which *satisfy* $f(x)$. This class may have no members, or, in the other extreme, the class may be the whole type of the arguments.

We thus conceive two general propositions respecting the indefinite number of propositions which share in the same logical form, that is, which are values of the same propositional function. One of these propositions is,

$f(x)$ yields a true proposition for each value of x of the proper type;

the other proposition is,

There is a value of x for which $f(x)$ is true.

Given two, or more, propositional functions $f(x)$ and $\psi(x)$ with the same argument x, we form derivative propositional functions, namely,

$f(x)$ or $\psi(x)$, $f(x)$ or not-$\psi(x)$,

and so on with the contradictories, obtaining, as in the arithmetical stage, an unending aggregate of propositional functions. Also each propositional function yields two general propositions. The theory of the interconnection between the truth-values of the general propositions arising from any such aggregate of propositional functions forms a simple and elegant chapter of mathematical logic.

In this algebraic section of logic the theory of types crops up, as

we have already noted. It cannot be neglected without the introduction of error. Its theory has to be settled at least by some safe hypothesis, even if it does not go to the philosophic basis of the question. This part of the subject is obscure and difficult, and has not been finally elucidated, though Russell's brilliant work has opened out the subject.

The final impulse to modern logic comes from the independent discovery of the importance of the logic variable by Frege and Peano. Frege went further than Peano, but by an unfortunate symbolism rendered his work so obscure that no one fully recognised his meaning who had not found it out for himself. But the movement has a large history reaching back to Leibniz and even to Aristotle. Among English contributors are De Morgan, Boole, and Sir Alfred Kempe; their work is of the first rank.

The third logical section is the stage of general-function theory. In logical language, we perform in this stage the transition from intension to extension, and investigate the theory of denotation. Take the propositional function $f(x)$. There is the class, or range of values for x, whose members satisfy $f(x)$. But the same range may be the class whose members satisfy another propositional function $\psi(x)$. It is necessary to investigate how to indicate the class by a way which is indifferent as between the various propositional functions which are satisfied by any member of it, and of it only. What has to be done is to analyse the nature of propositions about a class—namely, those propositions whose truth-values depend on the class itself and not on the particular meaning by which the class is indicated.

Furthermore, there are propositions about alleged individuals indicated by descriptive phrases: for example, propositions about "the present King of England," who does exist, and "the present Emperor of Brazil," who does not exist. More complicated, but analogous, questions involving propositional functions of two variables involve the notion of "correlation," just as functions of one argument involve classes. Similarly functions of three arguments yield three-cornered correlations, and so on. This logical section is one which Russell has made peculiarly his own by work which must always remain fundamental. I have called this the section of functional theory, because its ideas are essential to the construction of logical denoting functions which include as a special case ordinary

mathematical functions, such as sine, logarithm, etc. In each of these three stages it will be necessary gradually to introduce an appropriate symbolism, if we are to pass on to the fourth stage.

The fourth logical section, the analytic stage, is concerned with the investigation of the properties of special logical constructions, that is, of classes and correlations of special sorts. The whole of mathematics is included here. So the section is a large one. In fact, it is mathematics, neither more nor less, but it includes an analysis of mathematical ideas not hitherto included in the scope of that science, nor, indeed, contemplated at all. The essence of this stage is construction. It is by means of suitable constructions that the great framework of applied mathematics, comprising the theories of number, quantity, time, and space, is elaborated.

It is impossible, even in brief outline, to explain how mathematics is developed from the concepts of class and correlation, including many-cornered correlations, which are established in the third section. I can only allude to the headings of the process, which is fully developed in the work, *Principia Mathematica,* by Mr. Russell and myself. There are in this process of development seven special sorts of correlations which are of peculiar interest. The first sort comprises one-to-many, many-to-one, and one-to-one correlations. The second sort comprises serial relations, that is, correlations by which the members of some field are arranged in serial order, so that, in the sense defined by the relation, any member of the field is either before or after any other member. The third class comprises inductive relations, that is, correlations on which the theory of mathematical induction depends. The fourth class comprises selective relations, which are required for the general theory of arithmetic operations, and elsewhere. It is in connection with such relations that the famous multiplicative axiom arises for consideration. The fifth class comprises vector relations, from which the theory of quantity arises. The sixth class comprises ratio relations, which interconnect number and quantity. The seventh class comprises three-cornered and four-cornered relations which occur in geometry.

A bare enumeration of technical names, such as the above, is not very illuminating, though it may help to a comprehension of the demarcations of the subject. Please remember that the names are technical names, meant, no doubt, to be suggestive, but used in strictly defined senses. We have suffered much from critics who

consider it sufficient to criticise our procedure on the slender basis of a knowledge of the dictionary meanings of such terms. For example, a one-to-one correlation depends on the notion of a class with only one member, and this notion is defined without appeal to the concept of the number one. The notion of diversity is all that is wanted. Thus the class α has only one member, if (1) the class of values of x which satisfies the propositional function,

$$x \text{ is not a member of } \alpha,$$

is not the whole type of relevant values of x, and if (2) the propositional function,

$$x \text{ and } y \text{ are members of } \alpha, \text{ and } x \text{ is diverse from } y$$

is false, whatever be the values of x and y in the relevant type.

Analogous procedures are obviously possible for higher finite cardinal members. Thus, step by step, the whole cycle of current mathematical ideas is capable of logical definition. The process is detailed and laborious, and, like all science, knows nothing of a royal road of airy phrases. The essence of the process is, first, to construct the notion in terms of the forms of propositions, that is, in terms of the relevant propositional functions, and secondly, to prove the fundamental truths which hold about the notion by reference to the results obtained in the algebraic section of logic.

It will be seen that in this process the whole apparatus of special indefinable mathematical concepts, and special *a priori* mathematical premises, respecting number, quantity, and space, has vanished. Mathematics is merely an apparatus for analysing the deductions which can be drawn from any particular premises, supplied by common sense, or by more refined scientific observation, so far as these deductions depend on the forms of the propositions. Propositions of certain forms are continually occurring in thought. Our existing mathematics is the analysis of deductions which concern those forms and in some way are important, either from practical utility or theoretical interest. Here I am speaking of the science as it in fact exists. A theoretical definition of mathematics must include in its scope any deductions depending on the mere forms of propositions. But, of course no one would wish to develop that part of mathematics which in no sense is of importance.

This hasty summary of logical ideas suggests some reflections. The

question arises, How many forms of propositions are there? The answer is, An unending number. The reason for the supposed sterility of logical science can thus be discerned. Aristotle founded the science by conceiving the idea of the form of a proposition, and by conceiving deduction as taking place in virtue of the forms. But he confined propositions to four forms, now named A, I, E, O. So long as logicians were obsessed by this unfortunate restriction, real progress was impossible. Again, in their theory of form, both Aristotle and subsequent logicians came very near to the theory of the logical variable. But to come very near to a true theory, and to grasp its precise application, are two very different things, as the history of science teaches us. Everything of importance has been said before by somebody who did not discover it.

Again, one reason why logical deductions are not obvious is, that logical form is not a subject which ordinarily enters into thought. Common-sense deduction probably moves by blind instinct from concrete proposition to concrete proposition, guided by some habitual association of ideas. Thus common sense fails in the presence of a wealth of material.

A more important question is the relation of induction, based on observation, to deductive logic. There is a tradition of opposition between adherents of induction and of deduction. In my view, it would be just as sensible for the two ends of a worm to quarrel. Both observation and deduction are necessary for any knowledge worth having. We cannot get at an inductive law without having recourse to a propositional function. For example, take the statement of observed fact,

This body is mercury, and its specific heat is 0·033.

The propositional function is formed,

Either x is not mercury, or its specific heat is 0·033.

The inductive law is the assumption of the truth of the general proposition, that the above propositional function is true for every value of x in the relevant type.

But it is objected that this process and its consequences are so simple that an elaborate science is out of place. In the same way, a British sailor knows the salt sea when he sails over it. What then, is the use of an elaborate chemical analysis of sea-water? There is

the general answer, that you cannot know too much of methods which you always employ; and there is the special answer, that logical forms and logical implications are not so very simple, and that the whole of mathematics is evidence to this effect.

One great use of the study of logical method is not in the region of elaborate deduction, but to guide us in the study of the formation of the main concepts of science. Consider geometry, for example. What are the points which compose space? Euclid tells us that they are without parts and without magnitude. But how is the notion of a point derived from the sense-perceptions from which science starts? Certainly points are not direct deliverances of the senses. Here and there we may see or unpleasantly feel something suggestive of a point. But this is a rare phenomenon, and certainly does not warrant the conception of space as composed of points. Our knowledge of space properties is not based on any observations of relations between points. It arises from experience of relations between bodies. Now a fundamental space-relation between bodies is that one body may be part of another. We are tempted to define the 'whole and part' relation by saying that the points occupied by the part are some of the points occupied by the whole. But 'whole and part' being more fundamental than the notion of 'point,' this definition is really circular and vicious.

We accordingly ask whether any other definition of 'spatial whole and part' can be given. I think that it can be done in this way, though, if I be mistaken, it is unessential to my general argument. We have come to the conclusion that an extended body is nothing else than the class of perception of it by all its percipients, actual or ideal. Of course, it is not any class of perceptions, but a certain definite sort of class which I have not defined here, except by the vicious method of saying that they are perceptions of body. Now, the perceptions of a part of a body are among the perceptions which compose the whole body. Thus two bodies a and b are both classes of perceptions; and b is part of a when the class which is b is contained in the class which is a. It immediately follows from the logical form of this definition that if b is part of a, and c is part of b, then c is part of a. Thus the relation 'whole to part' is transitive. Again, it will be convenient to allow that a body is part of itself. This is a mere question of how you draw the definition. With this understanding, the relation is reflexive. Finally, if a is part of b, and

b is part of *a*, then *a* and *b* must be identical. These properties of 'whole and part' are not fresh assumptions, they follow from the logical form of our definition.

One assumption has to be made if we assume the ideal infinite divisibility of space. Namely, we assume that every class of perceptions which is an extended body contains other classes of perceptions which are extended bodies diverse from itself. This assumption makes rather a large draft on the theory of ideal perceptions. Geometry vanishes unless in some form you make it. The assumption is not peculiar to my exposition.

It is then possible to define what we mean by a point. A point is the class of extended objects which, in ordinary language, contain that point. The definition, without presupposing the idea of a point, is rather elaborate, and I have not now time for its statement.

The advantage of introducing points into geometry is the simplicity of the logical expression of their mutual relations. For science, simplicity of definition is of slight importance, but simplicity of mutual relations is essential. Another example of this law is the way physicists and chemists have dissolved the simple idea of an extended body, say of a chair, which a child understands, into a bewildering notion of a complex dance of molecules and atoms and electrons and waves of light. They have thereby gained notions with simpler logical relations.

Space as thus conceived is the exact formulation of the properties of the apparent space of the commonsense world of experience. It is not necessarily the best mode of conceiving the space of the physicist. The one essential requisite is that the correspondence between the common-sense world in its and the physicists' world in its space should be definite and reciprocal.

I will now break off the exposition of the function of logic in connection with the science of natural phenomena. I have endeavoured to exhibit it as the organising principle, analysing the derivation of the concepts from the immediate phenomena, examining the structure of the general propositions which are the assumed laws of nature, establishing their relations to each other in respect to reciprocal implications, deducing the phenomena we may expect under given circumstances.

Logic, properly used, does not shackle thought. It gives freedom, and above all, boldness. Illogical thought hesitates to draw conclu-

sions, because it never knows either what it means, or what it assumes, or how far it trusts its own assumptions, or what will be the effect of any modification of assumptions. Also the mind untrained in that part of constructive logic which is relevant to the subject in hand will be ignorant of the sort of conclusions which follow from various sorts of assumptions, and will be correspondingly dull in divining the inductive laws. The fundamental training in this relevant logic is, undoubtedly, to ponder with an active mind over the known facts of the case, directly observed. But where elaborate deductions are possible, this mental activity requires for its full exercise the direct study of the abstract logical relations. This is applied mathematics.

Neither logic without observation, nor observation without logic, can move one step in the formation of science. We may conceive humanity as engaged in an internecine conflict between youth and age. Youth is not defined by years but by the creative impulse to make something. The aged are those who, before all things, desire not to make a mistake. Logic is the olive branch from the old to the young, the wand which in the hands of youth has the magic property of creating science.

An Enquiry Concerning the Principles of Natural Knowledge

"PHILONOUS. *I am not for imposing any sense on your words: you are at liberty to explain them as you please. Only, I beseech you, make me understand something by them.*"

BERKELEY,
The First Dialogue Between
Hylas and Philonous

Chapter I Meaning 159
Chapter II The Foundations of Dynamical Physics 169
Chapter III Scientific Relativity 179
Chapter IV Congruence 192

AN ENQUIRY CONCERNING THE PRINCIPLES OF NATURAL KNOWLEDGE
THE CONCEPT OF NATURE
THE PRINCIPLE OF RELATIVITY

In the period from 1919 to 1922 Whitehead published three books, all of which deal with more or less the same topics and constitute his main contribution to the philosophy of science. The three books represent three different types of audience and emphasize different aspects of the same general problem. The Principle of Relativity comprises, as Whitehead says in the Preface, "an alternative rendering of the theory of relativity." The Concept of Nature, originally given as the Tarner Lectures at Trinity College, Cambridge, is perhaps the best exposition of the general topic for the general reader, while An Enquiry Concerning the Principles of Natural Knowledge is the most systematic exposition of the general point of view which Whitehead is trying to express.

In this anthology we have included Part I, comprising the first four chapters, of An Enquiry Concerning the Principles of Natural Knowledge; Chapters I through V and VII of The Concept of Nature; and Part I, the first four chapters, of The Principle of Relativity. We believe that our selections present all the major elements of Whitehead's thinking between 1919 and 1922. For further elucidation of some of the points, however, the remaining chapters of the three volumes should be consulted. For example, Chapter VII of The Concept of Nature on "Objects" is included here, but the same subject is treated in much greater detail in Part IV of An Enquiry Concerning the Principles of Natural Knowledge, which is omitted here. Similarly, Chapter IV of The Concept of Nature, included here, concerns "The Method of Extensive Abstraction"; but this is discussed in greater detail in Part III of The Principles of Knowledge, and, in the later revised form, in Part IV of Process and Reality.

It may be too much to suggest that in the title The Concept of Nature Whitehead uses "nature" only in a narrow sense; still the use of the word does recall the earlier paper On Mathematical Con-

cepts of the Material World. It is interesting to think of this book as an intermediary between the Royal Society paper and the cosmology of Process and Reality.

It should be noted that the enthusiasm of many philosophers for Whitehead's work reached its peak with these three books and waned as he developed his more metaphysical works later on. On the other hand his metaphysical admirers yield to none in their respect for the three, considering them as a brilliant exposition of one extremely important part of his total cosmology.

CHAPTER I *MEANING*

1. Traditional Scientific Concepts. 1·1. What is a physical explanation? The answer to this question, even when merely implicit in the scientific imagination, must profoundly affect the development of every science, and in an especial degree that of speculative physics. During the modern period the orthodox answer has invariably been couched in terms of Time (flowing equably in measurable lapses) and of Space (timeless, void of activity, euclidean), and of Material in space (such as matter, ether, or electricity).

The governing principle underlying this scheme is that extension, namely extension in time or extension in space, expresses disconnection. This principle issues in the assumptions that causal action between entities separated in time or in space is impossible and that extension in space and unity of being are inconsistent. Thus the extended material (on this view) is essentially a multiplicity of entities which, as extended, are diverse and disconnected. This governing principle has to be limited in respect to extension in time. The same material exists at different times. This concession introduces the many perplexities centering round the notion of change which is derived from the comparison of various states of self-identical material at different times.

1·2. The ultimate fact embracing all nature is (in this traditional point of view) a distribution of material throughout all space at a durationless instant of time, and another such ultimate fact will be another distribution of the same material throughout the same space at another durationless instant of time. The difficulties of this extreme statement are evident and were pointed out even in classical times when the concept first took shape. Some modification is evidently necessary. No room has been left for velocity, acceleration, momentum, and kinetic energy, which certainly are essential physical quantities.

We must therefore in the ultimate fact, beyond which science ceases to analyse, include the notion of a state of change. But a state of change at a durationless instant is a very difficult conception. It is impossible to define velocity without some reference to the past and the future. Thus

change is essentially the importation of the past and of the future into the immediate fact embodied in the durationless present instant.

This conclusion is destructive of the fundamental assumption that the ultimate facts for science are to be found at durationless instants of time.

1·3. The reciprocal causal action between materials *A* and *B* is the fact that their states of change are partly dependent on their relative locations and natures. The disconnection involved in spatial separation leads to reduction of such causal action to the transmission of stress across the bounding surface of contiguous materials. But what is contact? No two points are in contact. Thus the stress across a surface necessarily acts on some bulk of the material enclosed inside. To say that the stress acts on the immediately contiguous material is to assert infinitely small volumes. But there are no such things, only smaller and smaller volumes. Yet (with this point of view) it cannot be meant that the surface acts on the interior.

Certainly stress has the same claim to be regarded as an essential physical quantity as have momentum and kinetic energy. But no intelligible account of its meaning is to be extracted from the concept of the continuous distribution of diverse (because extended) entities through space as an ultimate scientific fact. At some stage in our account of stress we are driven to the concept of any extended quantity of material as a single unity whose nature is partly explicable in terms of its surface stress.

1·4. In biology the concept of an organism cannot be expressed in terms of a material distribution at an instant. The essence of an organism is that it is one thing which functions and is spread through space. Now functioning takes time. Thus a biological organism is a unity with a spatio-temporal extension which is of the essence of its being. This biological conception is obviously incompatible with the traditional ideas. This argument does not in any way depend on the assumption that biological phenomena belong to a different category to other physical phenomena. The essential point of the criticism on traditional concepts which has occupied us so far is that the concept of unities, functioning and with spatio-temporal extensions, cannot be extruded from physical concepts. The only reason for the introduction of biology is that in these sciences the same necessity becomes more clear.

1·5. The fundamental assumption to be elaborated in the course of this enquiry is that the ultimate facts of nature, in terms of which all

physical and biological explanation must be expressed, are events connected by their spatio-temporal relations, and that these relations are in the main reducible to the property of events that they can contain (or extend over) other events which are parts of them. In other words, in the place of emphasising space and time in their capacity of disconnecting, we shall build up an account of their complex essences as derivative from the ultimate ways in which those things, ultimate in science, are interconnected. In this way the data of science, those concepts in terms of which all scientific explanation must be expressed, will be more clearly apprehended. But before proceeding to our constructive task, some further realisation of the perplexities introduced by the traditional concepts is necessary.

2. Philosophic Relativity. 2·1. The philosophical principle of the relativity of space means that the properties of space are merely a way of expressing relations between things ordinarily said to be 'in space.' Namely, when two things are said to be 'both in space' what is meant is that they are mutually related in a certain definite way which is termed 'spatial.' It is an immediate consequence of this theory that all spatial entities such as points, straight lines and planes are merely complexes of relations between things or of possible relations between things.

For consider the meaning of saying that a particle P is at a point Q. This statement conveys substantial information and must therefore convey something more than the barren assertion of self-identity 'P is P.' Thus what must be meant is that P has certain relations to other particles P', P'', etc., and that the abstract possibility of this group of relations is what is meant by the point Q.

The extremely valuable work on the foundations of geometry produced during the nineteenth century has proceeded from the assumption of points as ultimate given entities. This assumption, for the logical purpose of mathematicians, is entirely justified. Namely the mathematicians ask, What is the logical description of relations between points from which all geometrical theorems respecting such relations can be deduced? The answer to this question is now practically complete; and if the old theory of absolute space be true, there is nothing more to be said. For points are ultimate simple existents, with mutual relations disclosed by our perceptions of nature.

But if we adopt the principle of relativity, these investigations do not solve the question of the foundations of geometry. An investigation into the foundations of geometry has to explain space as a complex of rela-

tions between things. It has to describe what a point is, and has to show how the geometric relations between points issue from the ultimate relations between the ultimate things which are the immediate objects of knowledge. Thus the starting point of a discussion on the foundations of geometry is a discussion of the character of the immediate data of perception. It is not now open to mathematicians to assume *sub silentio* that points are among these data.

2·2. The traditional concepts were evidently formed round the concept of absolute space, namely the concept of the persistent ultimate material distributed among the persistent ultimate points in successive configurations at successive ultimate instants of time. Here 'ultimate' means 'not analysable into a complex of simpler entities.' The introduction of the principle of relativity adds to the complexity—or rather, to the perplexity—of this conception of nature. The statement of general character of ultimate fact must now be amended into 'persistent ultimate material with successive mutual ultimate relations at successive ultimate instants of time.'

Space issues from these mutual relations of matter at an instant. The first criticism to be made on such an assertion is that it is shown to be a metaphysical fairy tale by any comparison with our actual perceptual knowledge of nature. Our knowledge of space is based on observations which take time and have to be successive, but the relations which constitute space are instantaneous. The theory demands that there should be an instantaneous space corresponding to each instant, and provides for no correlation between these spaces; while nature has provided us with no apparatus for observing them.

2·3. It is an obvious suggestion that we should amend our statement of ultimate fact, as modified by the acceptance of relativity. The spatial relations must now stretch across time. Thus if P, P', P'', etc. be material particles, there are definite spatial relations connecting P, P', P'', etc. at time t_1 with P, P', P'', etc. at time t_2, as well as such relations between P and P' and P'', etc. at time t_1 and such relations between P and P' and P'', etc. at time t_2. This should mean that P at time t_2 has a definite position in the spatial configuration constituted by the relations between P, P', P'', etc. at time t_1. For example, the sun at a certain instant on Jan. 1st, 1900 had a definite position in the instantaneous space constituted by the mutual relations between the sun and the other stars at a definite instant on Jan. 1st, 1800. Such a statement is only understandable (assuming the traditional concept) by recurring to absolute space

and thus abandoning relativity; for otherwise it denies the completeness of the instantaneous fact which is the essence of the concept. Another way out of the difficulty is to deny that space is constituted by the relations of P, P', P'', etc., at an instant, and to assert that it results from their relations throughout a duration of time, which as thus prolonged in time are observable.

As a matter of fact it is obvious that our knowledge of space does result from such observations. But we are asking the theory to provide us with actual relations to be observed. This last emendation is either only a muddled way of admitting that 'nature at an instant' is not the ultimate scientific fact, or else it is a yet more muddled plea that, although there is no possibility of correlations between distinct instantaneous spaces, yet within durations which are short enough such non-existent correlations enter into experience.

2·4. The persistence of the material lacks any observational guarantee when the relativity of space is admitted into the traditional concept. For at one instant there is instantaneous material in its instantaneous space as constituted by its instantaneous relations, and at another instant there is instantaneous material in its instantaneous space. How do we know that the two cargoes of material which load the two instants are identical? The answer is that we do not perceive isolated instantaneous facts, but a continuity of existence, and that it is this observed continuity of existence which guarantees the persistence of material. Exactly so; but this gives away the whole traditional concept. For a 'continuity of existence' must mean an unbroken duration of existence. Accordingly it is admitted that the ultimate fact for observational knowledge is perception through a duration; namely, that the content of a specious present, and not that of a durationless instant, is an ultimate datum for science.

2·5. It is evident that the conception of the instant of time as an ultimate entity is the source of all our difficulties of explanation. If there are such ultimate entities, instantaneous nature is an ultimate fact.

Our perception of time is as a duration, and these instants have only been introduced by reason of a supposed necessity of thought. In fact absolute time is just as much a metaphysical monstrosity as absolute space. The way out of the perplexities, as to the ultimate data of science in terms of which physical explanation is ultimately to be expressed, is to express the essential scientific concepts of time, space and material as issuing from fundamental relations between events and from recognitions of the characters of events. These relations of events are those

immediate deliverances of observation which are referred to when we say that events are spread through time and space.

3. Perception. 3·1. The conception of one universal nature embracing the fragmentary perceptions of events by one percipient and the many perceptions by diverse percipients is surrounded with difficulties. In the first place there is what we will call the 'Berkeleyan Dilemma' which crudely and shortly may be stated thus: Perceptions are in the mind and universal nature is out of the mind, and thus the conception of universal nature can have no relevance to our perceptual life. This is not how Berkeley stated his criticism of materialism; he was thinking of substance and matter. But this variation is a detail and his criticism is fatal to any of the traditional types of 'mind-watching-things' philosophy, even if those things be events and not substance or material. His criticisms range through every type of sense-perception, though in particular he concentrates on Vision.

3·2. "*Euphranor**. Tell me, Alciphron, can you discern the doors, windows, and battlements of that same castle?

Alciphron. I cannot. At this distance it seems only a small round tower.

Euph. But I, who have been at it, know that it is no small round tower, but a large square building with battlements and turrets, which it seems you do not see.

Alc. What will you infer from thence?

Euph. I would infer that the very object which you strictly and properly perceive by sight is not that thing which is several miles distant.

Alc. Why so?

Euph. Because a little round object is one thing, and a great square object is another. Is it not so?

Alc. I cannot deny it.

Euph. Tell me, is not the visible appearance alone the proper object of sight?

Alc. It is.

What think you now (said *Euphranor*, pointing towards the heavens) of the visible appearance of yonder planet? Is it not a round luminous flat, no bigger than a six-pence?

Alc. What then?

Euph. Tell me then, what you think of the planet itself? Do you not

* *Alciphron*, The Fourth Dialogue, Sec. 10.

conceive it to be a vast opaque globe, with several unequal risings and valleys?

Alc. I do.

Euph. How can you therefore conclude that the proper object of your sight exists at a distance?

Alc. I confess I do not know.

Euph. For your further conviction, do but consider that crimson cloud. Think you that, if you were in the very place where it is, you would perceive anything like what you now see?

Alc. By no means. I should perceive only a dark mist.

Euph. Is it not plain, therefore, that neither the castle, the planet, nor the cloud, which you see here, are those real ones which you suppose exist at a distance?"

3·3. Now the difficulty to be faced is just this. We may not lightly abandon the castle, the planet, and the crimson cloud, and hope to retain the eye, its retina, and the brain. Such a philosophy is too simple-minded—or at least might be thought so, except for its wide diffusion.

Suppose we make a clean sweep. Science then becomes a formula for calculating mental 'phenomena' or 'impressions.' But where is science? In books? But the castle and the planet took their libraries with them.

No, science is in the minds of men. But men sleep and forget, and at their best in any one moment of insight entertain but scanty thoughts. Science therefore is nothing but a confident expectation that relevant thoughts will occasionally occur. But by the bye, what has happened to time and space? They must have gone after the other things. No, we must distinguish: space has gone, of course; but time remains as relating the succession of phenomena. Yet this won't do; for this succession is only known by recollection, and recollection is subject to the same criticism as that applied by Berkeley to the castle, the planet, and the cloud. So after all, time does evaporate with space, and in their departure 'you' also have accompanied them; and I am left solitary in the character of a void of experience without significance.

3·4. At this point in the argument we may break off, having formed a short catalogue of the sort of considerations which lead from the Berkeleyan dilemma to a complete scepticism which was not in Berkeley's own thought.

There are two types of answer to this sceptical descent. One is Dr

Johnson's. He stamped his foot on a paving-stone, and went on his way satisfied with its reality. A scrutiny of modern philosophy will, if I am not mistaken, show that more philosophers should own Dr Johnson as their master than would be willing to acknowledge their indebtedness.

The other type of answer was first given by Kant. We must distinguish between the general way he set about constructing his answer to Hume, and the details of his system which in many respects are highly disputable. The essential point of his method is the assumption that 'significance' is an essential element in concrete experience. The Berkeleyan dilemma starts with tacitly ignoring this aspect of experience, and thus with putting forward, as expressing experience, conceptions of it which have no relevance to fact. In the light of Kant's procedure, Johnson's answer falls into its place; it is the assertion that Berkeley has not correctly expounded what experience in fact is.

Berkeley himself insists that experience is significant, indeed three-quarters of his writings are devoted to enforcing this position. But Kant's position is the converse of Berkeley's, namely that significance is experience. Berkeley first analyses experience, and then expounds his view of its significance, namely that it is God conversing with us. For Berkeley the significance is detachable from the experience. It is here that Hume came in. He accepted Berkeley's assumption that experience is something given, an impression, without essential reference to significance, and exhibited it in its bare insignificance. Berkeley's conversation with God then becomes a fairy tale.

3·5. What is 'significance'? Evidently this is a fundamental question for the philosophy of natural knowledge, which cannot move a step until it has made up its mind as to what is meant by this 'significance' which is experience.

'Significance' is the relatedness of things. To say that significance is experience, is to affirm that perceptual knowledge is nothing else than an apprehension of the relatedness of things, namely of things in their relations and as related. Certainly if we commence with a knowledge of things, and then look around for their relations we shall not find them. 'Causal connection' is merely one typical instance of the universal ruin of relatedness. But then we are quite mistaken in thinking that there is a possible knowledge of things as unrelated. It is thus out of the question to start with a knowledge of things antecedent to a knowledge of their relations. The so-called properties of things can always be expressed as

their relatedness to other things unspecified, and natural knowledge is exclusively concerned with relatedness.

3·6. The relatedness which is the subject of natural knowledge cannot be understood without reference to the general characteristics of perception. Our perception of natural events and natural objects is a perception from within nature, and is not an awareness contemplating all nature impartially from without. When Dr Johnson 'surveyed mankind from China to Peru,' he did it from Pump Court in London at a certain date. Even Pump Court was too wide for his peculiar *locus standi;* he was really merely conscious of the relations of his bodily events to the simultaneous events throughout the rest of the universe. Thus perception involves a percipient object, a percipient event, the complete event which is all nature simultaneous with the percipient event, and the particular events which are perceived as parts of the complete event. This general analysis of perception will be elaborated in Part II. The point here to be emphasised is that natural knowledge is a knowledge from within nature, a knowledge 'here within nature' and 'now within nature,' and is an awareness of the natural relations of one element in nature (namely, the percipient event) to the rest of nature. Also what is known is not barely the things but the relations of things, and not the relations in the abstract but specifically those things as related.

Thus Alciphron's vision of the planet is his perception of his relatedness (i.e. the relatedness of his percipient event) to some other elements of nature which as thus related he calls the planet. He admits in the dialogue that certain other specified relations of those elements are possible for other percipient events. In this he may be right or wrong. What he directly knows is his relation to some other elements of the universe—namely, I, Alciphron, am located in my percipient event 'here and now' and the immediately perceived appearance of the planet is for me a characteristic of another event 'there and now.' In fact perceptual knowledge is always a knowledge of the relationship of the percipient event to something else in nature. This doctrine is in entire agreement with Dr Johnson's stamp of the foot by which he realised the otherness of the paving-stone.

3·7. The conception of knowledge as passive contemplation is too inadequate to meet the facts. Nature is ever originating its own development, and the sense of action is the direct knowledge of the percipient event as having its very being in the formation of its natural relations.

Knowledge issues from this reciprocal insistence between this event and the rest of nature, namely relations are perceived in the making and because of the making. For this reason perception is always at the utmost point of creation. We cannot put ourselves back to the Crusades and know their events while they were happening. We essentially perceive our relations with nature because they are in the making. The sense of action is that essential factor in natural knowledge which exhibits it as a self-knowledge enjoyed by an element of nature respecting its active relations with the whole of nature in its various aspects. Natural knowledge is merely the other side of action. The forward moving time exhibits this characteristic of experience, that it is essentially action. This passage of nature—or, in other words, its creative advance—is its fundamental characteristic; the traditional concept is an attempt to catch nature without its passage.

3·8. Thus science leads to an entirely incoherent philosophy of perception in so far as it restricts itself to the ultimate datum of material in time and space, the spatio-temporal configuration of such material being the object of perception. This conclusion is no news to philosophy, but it has not led to any explicit reorganisation of the concepts actually employed in science. Implicitly, scientific theory is shot through and through with notions which are frankly inconsistent with its explicit fundamental data.

This confusion cannot be avoided by any kind of theory in which nature is conceived simply as a complex of one kind of inter-related elements such as either persistent things, or events, or sense-data. A more elaborate view is required of which an explanation will be attempted in the sequel. It will suffice here to say that it issues in the assertion that all nature can (in many diverse ways) be analysed as a complex of things; that all nature can be analysed as a complex of events, and all nature can be analysed as a complex of sense-data. The elements which result from such analyses, events, and sense-data, are aspects of nature of fundamentally different types, and the confusions of scientific theory have arisen from the absence of any clear recognition of the distinction between relations proper to one type of element and relations proper to another type of element. It is of course a commonplace that elements of these types are fundamentally different. What is here to be insisted on is the way in which this commonplace truth is important in yielding an analysis of the ultimate data for science more elaborate than that of its current tradition. We have to remember that while nature is complex

with time-less subtlety, human thought issues from the simple-mindedness of beings whose active life is less than half a century.

CHAPTER II *THE FOUNDATIONS OF DYNAMICAL PHYSICS*

4. Newton's Laws of Motion. 4·1. The theoretical difficulties in the way of the application of the philosophic doctrine of relativity have never worried practical scientists. They have started with the working assumptions that in some sense the world is in one euclidean space, that the permanent points in such a space have no individual characteristics recognisable by us, except so far as they are occupied by recognisable material or except in so far as they are defined by assigned spatial relations to points which are thus definitely recognisable, and that according to the purpose in hand either the earth can be assumed to be at rest or else astronomical axes which are defined by the aid of the solar system, of the stars, and of dynamical considerations deduced from Newton's laws of motion.

4·2. Newton's laws* of motion presuppose the notions of mass and force. Mass arises from the conception of a passive quality of a material body, what it is in itself apart from its relation to other bodies; the notion of 'force' is that of an active agency changing the physical circumstances of the body, and in particular its spatial relations to other bodies. It is fairly obvious that mass and force were introduced into science as the outcome of this antithesis between intrinsic quality and agency, although further reflection may somewhat mar the simplicity of this outlook. Mass and force are measurable quantities, and their numerical expressions are dependent on the units chosen. The mass of a body is constant, so long as the body remains composed of the same self-identical material. Velocity, acceleration and force are vector quantities, namely they have direction as well as magnitude. They are thus representable by straight lines drawn from any arbitrary origin.

4·3. These laws of motion are among the foundations of science; and certainly any alteration in them must be such as to produce effects observable only under very exceptional circumstances. But, as is so often the case in science, a scrutiny of their meaning produces many perplexities.

* Cf. Appendix I to this chapter.

In the first place we can sweep aside one minor difficulty. In our experience, a finite mass of matter occupies a volume and not a point. Evidently therefore the laws should be stated in an integral form, involving at certain points of the exposition greater elaboration of statement. These forms are stated (with somewhat abbreviated explanation) in dynamical treatises.

Secondly, Lorentz's distinction between macroscopic equations and microscopic equations forces itself on us at once, by reason of the molecular nature of matter and the dynamical nature of heat. A body apparently formed of continuous matter with its intrinsic geometrical relations nearly invariable is in fact composed of agitated molecules. The equations of motion for such a body as used by an engineer or an astronomer are, in Lorentz's nomenclature, macroscopic. In such equations even a differential element of volume is to be supposed to be sufficiently large to average out the diverse agitations of the molecules, and to register only the general unbalanced residuum which to ordinary observation is the motion of the body.

The microscopic equations are those which apply to the individual molecules. It is at once evident that a series of such sets of equations is possible, in which the adjacent sets are macroscopic and microscopic relatively to each other. For example, we may penetrate below the molecule to the electrons and the core which compose it, and thus obtain infra-molecular equations. It is purely a question as to whether there are any observed phenomena which in this way receive their interpretation.

The inductive evidence for the validity of Newton's equations of motion, within the experimental limits of accuracy, is obviously much stronger in the case of the macroscopic equations of the engineer and the astronomer than it is in the case of the microscopic equations of the molecule, and very much stronger than in the case of the infra-microscopic equations of the electron. But there is good evidence that even the infra-microscopic equations conform to Newton's laws as a first approximation. The traces of deviation arise when the velocities are not entirely negligible compared to that of light.

4·4. What do we know about masses and about forces? We obtain our knowledge of forces by having some theory about masses, and our knowledge of masses by having some theory about forces. Our theories about masses enable us in certain circumstances to assign the numerical ratios of the masses of the bodies involved; then the observed motions

of these bodies will enable us to register (by the use of Newton's laws of motion) the directions and magnitudes of the forces involved, and thence to frame more extended theories as to the laws regulating the production of force. Our theories about the direction and comparative magnitudes of forces and the observed motions of the bodies will enable us to register (by the use of Newton's laws of motion) the comparative magnitudes of masses. The final results are to be found in engineers' pocket-books, in tables of physical constants for physicists, and in astronomical tables. The verification is the concordant results of diverse experiments. One essential part of such theories is the judgment of circumstances which are sufficiently analogous to warrant the assumption of the same mass or the same magnitude of force in assigned diverse cases. Namely the theories depend upon the fact of recognition.

4·5. It has been popular to define force as the product of mass and acceleration. The difficulty to be faced with this definition is that the familiar equation of elementary dynamics, namely,

$$mf = P,$$

now becomes

$$mf = mf.$$

It is not easy to understand how an important science can issue from such premisses. Furthermore the simple balancing of a weight by the tension of the supporting spring receives a very artificial meaning. With equal reason we might start with our theories of force as fundamental, and define mass as force divided by acceleration. Again we should be in equal danger of reducing dynamical equations to such identities as

$$P/f = P/f.$$

Also the permanent mass of a bar of iron receives a very artificial meaning.

5. The Ether. 5·1. The theory of stress between distant bodies, considered as an ultimate fact, was repudiated by Newton himself, but was adopted by some of his immediate successors. In the nineteenth century the belief in action at a distance has steadily lost ground.

There are four definite scientific reasons for the adoption of the opposite theory of the transmission of stress through an intermediate medium which we will call the 'ether.' These reasons are in addition to the somewhat vague philosophic preferences, based on the disconnection involved in spatial and temporal separation. In the first place, the wave theory of light also postulates an ether, and thus brings concurrent testi-

mony to its existence. Secondly, Clerk Maxwell produced the formulae for the stresses in such an ether which, if they exist, would account for gravitational, electrostatic, and magnetic attractions. No theory of the nature of the ether is thereby produced which in any way explains why such stresses exist; and thus their existence is so far just as much a disconnected assumption as that of the direct stresses between distant bodies. Thirdly, Clerk Maxwell's equations of the electromagnetic field presuppose events and physical properties of apparently empty space. Accordingly there must be something, i.e. an ether, in the empty space to which these properties belong. These equations are now recognised as the foundations of the exact science of electromagnetism, and stand on a level with Newton's equations of motion. Thus another testimony is added to the existence of an ether.

Lastly, Clerk Maxwell's identification of light with electromagnetic waves shows that the same ether is required by the apparently diverse optical and electro-magnetic phenomena. The objection is removed that fresh properties have to be ascribed to the ether by each of the distinct lines of thought which postulate it.

It will be observed that gravitation stands outside this unification of scientific theory due to Maxwell's work, except so far that we know the stresses in the ether which would produce it.

5·2. The assumption of the existence of an ether at once raises the question as to its laws of motion. Thus in addition to the hierarchy of macroscopic and microscopic equations, there are the equations of motion for ether in otherwise empty space. The *à priori* reasons for believing that Newton's laws of motion apply to the ether are very weak, being in fact nothing more than the inductive extension of laws to cases widely dissimilar from those for which they have been verified. It is however a sound scientific procedure to investigate whether the assumed properties of ether are explicable on the assumption that it is behaving like ordinary matter, if only to obtain suggestions by contrast for the formulation of the laws which do express its physical changes.

The best method of procedure is to assume certain large principles deducible from Newton's laws and to interpret certain electromagnetic vectors as displacements and velocities of the ether. In this way Larmor has been successful in deducing Maxwell's equations from the principle of least action after making the necessary assumptions. In this he is only following a long series of previous scientists who during the nineteenth century devoted themselves to the explanation of optical and

electromagnetic phenomena. His work completes a century of very notable achievement in this field.

5·3. But it may be doubted whether this procedure is not an inversion of the more fundamental line of thought. It will have been noted that Newton's equations, or any equivalent principles which are substituted for them, are in a sense merely blank forms. They require to be supplemented by hypotheses respecting the nature of the stresses, of the masses, and of the motions, before there can be any possibility of their application. Thus by the time that Newton's equations of motion are applied to the explication of etherial events there is a large accumulation of hypotheses respecting things of which we know very little. What in fact we do know about the ether is summed up in Maxwell's equations, or in recent adaptations of his equations such as those due to Lorentz. The discovery of electromagnetic mass and electromagnetic momentum suggests that, for the ether at least, we gain simpler conceptions of the facts by taking Maxwell's equations, or the Lorentz-Maxwell equations, as fundamental. Such equations would then be the ultimate microscopic equations, at least in the present stage of science, and Newton's equations become macroscopic equations which apply in certain definite circumstances to etherial aggregates. Such a procedure does not prejudge the debated theory of the purely electromagnetic origin of mass.

5·4. The modern theory of the molecule is destructive of the obviousness of the prejudgment in favour of the traditional concepts of ultimate material at an instant. Consider a molecule of iron. It is composed of a central core of positive electricity surrounded by annular clusters of electrons, composed of negative electricity and rotating round the core. No single characteristic property of iron as such can be manifested at an instant. Instantaneously there is simply a distribution of electricity and Maxwell's equations to express our expectations. But iron is not an expectation or even a recollection. It is a fact; and this fact, which is iron, is what happens during a period of time. Iron and a biological organism are on a level in requiring time for functioning. There is no such thing as iron at an instant; to be iron is a character of an event. Every physical constant respecting iron which appears in scientific tables is the register of such a character. What is ultimate in iron, according to the traditional theory, is instantaneous distributions of electricity; and this ultimateness is simply ascribed by reason of a metaphysical theory, and by no reason of observation.

5·5. In truth, when we have once admitted the hierarchy of macro-

scopic and microscopic equations, the traditional concept is lost. For it is the macroscopic equations which express the facts of immediate observation, and these equations essentially express the integral characters of events. But this hierarchy is necessitated by every concept of modern physics—the molecular theory of matter, the dynamical theory of heat, the wave theory of light, the electromagnetic theory of molecules, the electromagnetic theory of mass.

6. *Maxwell's Equations**. 6·1. A discussion of Maxwell's equations would constitute a treatise on electromagnetism. But they exemplify some general considerations on physical laws.

These equations (expressed for an axis-system a) involve for each point of space and each instant of time the vector quantities (F_a, G_a, H_a), (L_a, M_a, N_a) and (u_a, v_a, w_a), namely the electric and magnetic 'forces' and the velocity of the charge of electricity. Now a vector involves direction; and direction is not concerned with what is merely at that point. It is impossible to define direction without reference to the rest of space; namely, it involves some relation to the whole of space.

Again the equations involve the spatial differential operators $\frac{\partial}{\partial x_a}, \frac{\partial}{\partial y_a}, \frac{\partial}{\partial z_a}$, which enter through the symbols curl_a and div_a; and they also involve the temporal differential operator $\frac{\partial}{\partial t_a}$. The differential coefficients thus produced essentially express properties in the neighbourhood of the point (x_a, y_a, z_a) and of the time t_a, and not merely properties at (x_a, y_a, z_a, t_a). For a differential coefficient is a limit, and the limit of a function at a given value of its argument expresses a property of the aggregate of the values of the function corresponding to the aggregate of the values of the argument in the neighbourhood of the given value.

This is essentially the same argument as that expressed above in 1·2 for the particular case of motion. Namely, we cannot express the facts of nature as an aggregate of individual facts at points and at instants.

6·2. In the Lorentz-Maxwell equations [cf. Appendix II] there is no reference to the motion of the ether. The velocity (u_a, v_a, w_a) which appears in them is the velocity of the electric charge. What then are the equations of motion of the ether? Before we puzzle over this question, a preliminary doubt arises. Does the ether move?

Certainly, if science is to be based on the data included in the Lorentz-

* Cf. Appendix II to this chapter.

Maxwell equations, even if the equations be modified, the motion of the ether does not enter into experience. Accordingly Lorentz assumes a stagnant ether: that is to say, an ether with no motion, which is simply the ultimate entity of which the vectors (F_a, G_a, H_a) and (L_a, M_a, N_a) express properties. Such an ether has certainly a very shadowy existence; and yet we cannot assume that it moves, merely for the sake of giving it something to do.

6·3. The ultimate facts contemplated in Maxwell's equations are the occurrences of ρ_a (the volume-density of the charge), (u_a, v_a, w_a), (F_a, G_a, H_a), and (L_a, M_a, N_a) at the space-time points in the neighbourhood surrounding the space-time point (x_a, y_a, z_a, t_a). But this is merely to say that the ultimate facts contemplated by Maxwell's equations are certain events which are occurring throughout all space. The material called ether is merely the outcome of a metaphysical craving. The continuity of nature is the continuity of events; and the doctrine of transmission should be construed as a doctrine of the coextensiveness of events with space and time and of their reciprocal interaction. In this sense an ether can be admitted; but, in view of the existing implication of the term, clearness is gained by a distinction of phraseology. We shall term the traditional ether an 'ether of material' or a 'material ether,' and shall employ the term 'ether of events' to express the assumption of this enquiry, which may be loosely stated as being 'that something is going on everywhere and always.' It is our purpose to express accurately the relations between these events so far as they are disclosed by our perceptual experience, and in particular to consider those relations from which the essential concepts of Time, Space, and persistent material are derived. Thus primarily we must not conceive of events as in a given Time, a given Space, and consisting of changes in given persistent material. Time, Space, and Material are adjuncts of events. On the old theory of relativity, Time and Space are relations between materials; on our theory they are relations between events.

APPENDIX I TO CHAPTER II

NEWTON'S LAWS OF MOTION

Let $(O_a X_a Y_a Z_a)$ as in the accompanying figure be rectangular axes at rest; let $(\dot{x}_{ap}, \dot{y}_{ap}, \dot{z}_{ap})$ be the velocity of a material particle p of mass m at (x_a, y_a, z_a) relative to these axes, and let $(\ddot{x}_{ap}, \ddot{y}_{ap}, \ddot{z}_{ap})$ be the acceleration of the same particle. Also let (X_{ap}, Y_{ap}, Z_{ap}) be the force on the particle p.

The first two of Newton's laws can be compressed into the equations

$$m\ddot{x}_{ap} = X_{ap}, m\ddot{y}_{ap} = Y_{ap}, m\ddot{z}_{ap} = Z_{ap}. \quad . \quad . \quad . \quad . \quad . \quad . (1)$$

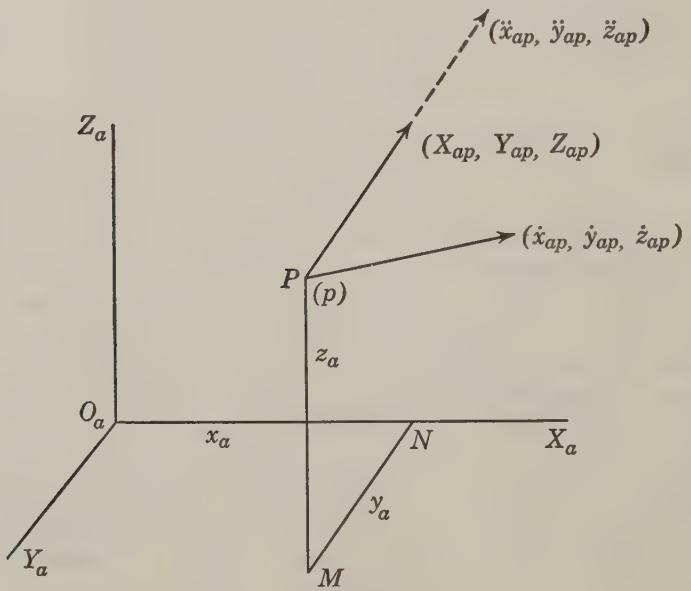


Fig. 1.

It is unnecessary to trace the elementary consequences of these equations.

The third law of motion considers a fundamental characteristic of force and is founded on the sound principle that all agency is nothing else than relations between those entities which are among the ultimate data of science. The law is, Action and reaction are equal and opposite. This means that there must be particles p', p'', p''', etc. to whose agency (X_{ap}, Y_{ap}, Z_{ap}) are due, and that we can write

$$\left.\begin{aligned} X_{ap} &= X_{app'} + X_{app''} + \ldots \\ Y_{ap} &= Y_{app'} + Y_{app''} + \ldots \\ Z_{ap} &= Z_{app'} + Z_{app''} + \ldots \end{aligned}\right\}, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . (2)$$

where $(X_{app'}, Y_{app'}, Z_{app'})$ is due to p' alone, $(X_{app''}, Y_{app''}, Z_{app''})$ to p'' alone, and so on.

Furthermore let the particle p' be at (x_a', y_a', z_a') and $(\ddot{x}'_{ap'}, \ddot{y}'_{ap'}, \ddot{z}'_{ap'})$ be the acceleration of p'. Also let $(X_{ap'}, Y_{ap'}, Z_{ap'})$ be the force on

p'; and let $X_{ap'p}$, $Y_{ap'p}$, etc. have meanings for p' analogous to those which $X_{app'}$, etc. have for p. Then according to the third law the two forces

$$(X_{app'}, Y_{app'}, Z_{app'}) \text{ and } (X_{ap'p}, Y_{ap'p}, Z_{ap'p})$$

are equal and opposite, namely they are equal in magnitude, opposite in direction, and along the line joining p and p'. These requirements issue in two sets of equations

$$X_{app'} + X_{ap'p} = 0,\ Y_{app} + Y_{ap'p} = 0,\ Z_{app'} + Z_{ap'p} = 0 \quad . \quad . \quad (3)$$

and $$(y_a Z_{app'} - z_a Y_{app'}) + (y_a' Z_{ap'p} - z_a' Y_{ap'p}) = 0, \quad . \quad . \quad . \quad . \quad (4)$$

with two analogous equations.

The two equal and opposite forces on p and p', due to their mutual direct agency, namely,

$$(X_{app'}, Y_{app'}, Z_{app'}) \text{ and } (X_{ap'p}, Y_{ap'p}, Z_{ap'p}),$$

together constitute what is called a 'stress between p and p'.'

Thus the third law of motion falls into three parts, symbolised by the three sets of equations (2), (3) and (4). The set (2) expresses that all force on matter is due to stresses between it and other matter; and sets (3) and (4) express the two fundamental characteristics of stresses. We need not stop to enquire whether the short verbal expression of the law logically expresses these three properties. This is a minor point of exposition dependent on the context in which this formulation of the law is found.

APPENDIX II TO CHAPTER II

MAXWELL'S EQUATIONS

It will be convenient to state these equations in the slightly modified form which is due to Lorentz. Space is referred to the fixed rectangular axis system α, as in subarticle 6·1. It will be necessary to explain a few small points of nomenclature and notation.

A vector is a directed physical quantity; for example, the electric force at a point is a vector. This example also shows that we have to conceive vectors which have analogous significations at different points of space. Such a vector is the electric force which may have a distinct magnitude and direction at each point of space, but expresses at all points one definite physical fact. Such a vector will be a function of its

position, that is to say, of the coordinates of the point (x_a, y_a, z_a) of which it is that characteristic vector.

Let (X_a, Y_a, Z_a) be any such vector. Then X_a and Y_a and Z_a are each of them functions of (x_a, y_a, z_a) and also of the time t_a, i.e. they are functions of x_a, y_a, z_a, t_a. We shall assume that our physical quantities are differentiable, except possibly at exceptional points.

Let $q(X_a, Y_a, Z_a)$ stand for (qX_a, qY_a, qZ_a), and analogously

$$\frac{\partial}{\partial t}(X_a, Y_a, Z_a) \text{ for } \left(\frac{\partial X_a}{\partial t_a}, \frac{\partial Y_a}{\partial t_a}, \frac{\partial Z_a}{\partial t_a}\right);$$

also $$\operatorname{div}_a(X_a, Y_a, Z_a) \text{ for } \frac{\partial X_a}{\partial x_a} + \frac{\partial Y_a}{\partial y_a} + \frac{\partial Z_a}{\partial z_a},$$

and $\operatorname{curl}_a (X_a, Y_a, Z_a)$ for the vector

$$\left(\frac{\partial Z_a}{\partial y_a} - \frac{\partial Y_a}{\partial z_a}, \frac{\partial X_a}{\partial z_a} - \frac{\partial Z_a}{\partial x_a}, \frac{\partial Y_a}{\partial x_a} - \frac{\partial X_a}{\partial y_a}\right).$$

Finally if (X_a', Y_a', Z_a') be another vector at the same point, then

$$[(X_a', Y_a', Z_a'). (X_a, Y_a, Z_a)]$$

stands for what is called the 'vector product' of the two vectors, namely the vector

$$(Y_a'Z_a - Z_a'Y_a, Z_a'X_a - X_a'Z_a, X_a'Y_a - Y_a'X_a).$$

It is evident that $\operatorname{curl}_a (X_a, Y_a, Z_a)$ can be expressed in the symbolic form

$$\left[\left(\frac{\partial}{\partial x_a}, \frac{\partial}{\partial y_a}, \frac{\partial}{\partial z_a}\right).(X_a, Y_a, Z_a)\right].$$

The vector equation

$$(X_a, Y_a, Z_a) = (X_a', Y_a', Z_a')$$

is an abbreviation of the three equations

$$X_a = X_a', Y_a = Y_a', Z_a = Z_a'.$$

Let (F_a, G_a, H_a) be the electric force at (x_a, y_a, z_a, t_a), and let (L_a, M_a, N_a) be the magnetic force at the same point and time. Also let ρ_a be the volume density of the electric charge and (u_a, v_a, w_a) its velocity; and let (P_a, Q_a, R_a) be the ponderomotive force: all equally at (x_a, y_a, z_a, t_a). Finally let c be the velocity of light *in vacuo*.

Then Lorentz's form of Maxwell's equations is

$$\mathrm{div}_a\,(F_a,\ G_a,\ H_a) = \rho_a, \quad \ldots\ldots\ldots\ldots (1)$$

$$\mathrm{div}_a\,(L_a,\ M_a,\ N_a) = 0, \quad \ldots\ldots\ldots\ldots (2)$$

$$\mathrm{curl}_a\,(L_a,\ M_a,\ N_a) = \frac{1}{c}\left\{\frac{\partial}{\partial t_a}\,(F_a,\ G_a,\ H_a) + \rho_a\,(u_a,\ v_a,\ w_a)\right\}, \quad \ldots (3)$$

$$\mathrm{curl}_a\,(F_a,\ G_a,\ H_a) = -\frac{1}{c}\frac{\partial}{\partial t_a}\,(L_a,\ M_a,\ N_a), \quad \ldots\ldots (4)$$

$$(P_a,\ Q_a,\ R_a) = (F_a,\ G_a,\ H_a) + \frac{1}{c}\,[(u_a,\ v_a,\ w_a).(L_a,\ M_a,\ N_a)]. \quad \ldots (5)$$

It will be noted that each of the vector equations (3), (4), (5) stands for three ordinary equations, so that there are eleven equations in the five formulae.

CHAPTER III *SCIENTIFIC RELATIVITY*

7. Consentient Sets. 7·1. A traveller in a railway carriage sees a fixed point of the carriage. The wayside stationmaster knows that the traveller has been in fact observing a track of points reaching from London to Manchester. The stationmaster notes his station as fixed in the earth. A being in the sun conceives the station as exhibiting a track in space round the sun, and the railway carriage as marking out yet another track. Thus if space be nothing but relations between material bodies, points as simple entities disappear. For a point according to one type of observation is a track of points according to another type. Galileo and the Inquisition are only in error in the single affirmation in which they both agreed, namely that absolute position is a physical fact—the sun for Galileo and the earth for the Inquisition.

7·2. Thus each rigid body defines its own space, with its own points, its own lines, and its own surfaces. Two bodies may agree in their spaces; namely, what is a point for either may be a point for both. Also if a third body agrees with either, it will agree with both. The complete set of bodies, actual or hypothetical, which agree in their space-formation will be called a 'consentient' set.

The relation of a 'dissentient' body to the space of a consentient set

is that of motion through it. The dissentient body will itself belong to another consentient set. Every body of this second set will have a motion in the space of the first set which has the same general spatial characteristics as every other body of the second consentient set; namely (in technical language) it will at any instant be a screw motion with the same axis, the same pitch and the same intensity—in short the same screw-motion for all bodies of the second set. Thus we will speak of the motion of one consentient set in the space of another consentient set. For example such a motion may be translation without rotation, and the translation may be uniform or accelerated.

7·3. Now observers in both consentient sets agree as to what is happening. From different standpoints in nature they both live through the same events, which in their entirety are all that there is in nature. The traveller and the stationmaster both agree as to the existence of a certain event—for the traveller it is the passage of the station past the train, and for the stationmaster it is the passage of the train past the station. The two sets of observers merely diverge in setting the same events in different frameworks of space and (according to the modern doctrine) also of time.

This spatio-temporal framework is not an arbitrary convention. Classification is merely an indication of characteristics which are already there. For example, botanical classification by stamens and pistils and petals applies to flowers, but not to men. Thus the space of the consentient set is a fact of nature; the traveller with the set only discovers it.

8. Kinematic Relations. 8·1. The theory of relative motion is the comparison of the motion of a consentient set β in the space of a consentient set α with the motion of α in the space of β. This involves a preliminary comparison of the space of α with the space of β. Such a comparison can only be made by reference to events which are facts common to all observers, thus showing the fundamental character of events in the formation of space and time. The ideally simple event is one indefinitely restricted both in spatial and in temporal extension, namely the instantaneous point. We will use the term 'event-particle' in the sense of 'instantaneous point-event.' The exact meaning of the ideal restriction in extension of an event-particle will be investigated in Part III; here we will assume that the concept has a determinate signification.

8·2. An event-particle occupies instantaneously a certain point in the space of α and a certain point in the space of β. Thus instantaneously there is a certain correlation between the points of the space of α and

the points of the space of β. Also if the particle has the character of material at rest at the point in the space of α, this material-particle has a certain velocity in the space of β; and if it be material at rest at the point in the space of β, the material-particle has a certain velocity in the space of α. The direction in β-space of the velocity due to rest in the correlated α-point is said to be opposite to the direction in α-space of the velocity due to rest in the correlated β-point. Also with congruent units of space and of time, the measures of the velocities are numerically equal. The consequences of these fundamental facts are investigated in Part III. The relation of the α-space to the β-space which is expressed by the velocities at points in α-space due to rest in the points of β-space and by the opposite velocities in β-space due to rest in the points of α-space is called the 'kinematic relation' between the two consentient sets, or between the two spaces.

8·3. The simplest form of this kinematic relation between a pair of consentient sets is when the motion of either set in the space of the other is a uniform translation without acceleration and without rotation. Such a kinematic relation will be called 'simple.' If a consentient group α has a simple kinematic relation to each of two consentient sets, β and γ, then β and γ have a simple kinematic relation to each other. In technical logical language a simple kinematic relation is symmetrical and transitive.

The whole group of consentient sets with simple kinematic relations to any one consentient set, including that set itself, is called a 'simple' group of consentient sets.

The kinematic relation is called 'translatory' when the relative motion does not involve rotation; namely, it is a translation but not necessarily uniform.

8·4. The fact that the relational theory of space involves that each consentient set has its own space with its own peculiar points is ignored in the traditional presentation of physical science. The reason is that the absolute theory of space is not really abandoned, and the relative motion, which is all that can be observed, is treated as the differential effect of two absolute motions.

8·5. In the enunciation of Newton's Laws of Motion, the velocities and accelerations of particles must be supposed to refer to the space of some given consentient set. Evidently the acceleration of a particle is the same in all the spaces of a simple group of consentient sets—at least this has hitherto been the unquestioned assumption. Recently this

assumption has been questioned and does not hold in the new theory of relativity. Its axiomatic obviousness only arises from the covert assumption of absolute space. In the new theory Newton's equations themselves require some slight modification which need not be considered at this stage of the discussion.

In either form, their traditional form or their modified form, Newton's equations single out one and only one simple group of consentient sets, and require that the motions of matter be referred to the space of any one of these sets. If the proper group be chosen the third law of action and reaction holds. But if the laws hold for one simple group, they cannot hold for any other such group. For the apparent forces on particles cannot then be analysed into reciprocal stresses in the space of any set not a member of the original simple group.

Let the simple group for which the laws do hold be called the 'Newtonian' group.

8·6. Then, for example, if a consentient set α have a non-uniform translatory kinematic relation to members of the Newtonian group, the particles of the material universe would, when their motions are referred to the α-space, appear to be acted on by forces parallel to a fixed direction, in the same sense along that direction, and proportional to the mass of the particle acted on. Such an assemblage of forces cannot be expressed as an assemblage of reciprocal stresses between particles. Again if a consentient set β have a non-translatory kinematic relation to the members of the Newtonian group, then, when motion is referred to the β-space, 'centrifugal' and 'composite centrifugal' forces on particles make their appearance; and these forces cannot be reduced to stresses.

8·7. The physical consequences of this result are best seen by taking a particular case. The earth is rotating and its parts are held together by their mutual gravitational attractions. The result is that the figure bulges at the equator; and, after allowing for the deficiencies of our observational knowledge, the results of theory and experiment are in fair agreement.

The dynamical theory of this investigation does not depend on the existence of any material body other than the earth. Suppose that the rest of the material universe were annihilated, or at least any part of it which is visible to our eye-sight. Why not? For after all there is a very small volume of visible matter compared to the amount of space available for it. So there is no reason to assume anything very essential

in the existence of a few planets and a few thousand stars. We are left with the earth rotating. But rotating relatively to what? For on the relational theory it would seem to be the mutual relations of the earth's parts which constitute space. And yet the dynamical theory of the bulge does not refer to any body other than the earth, and so is not affected by the catastrophe of annihilation. It has been asserted that after all the fixed stars are essential, and that it is the rotation relatively to them which produces the bulge. But surely this ascription of the centrifugal force on the earth's surface to the influence of Sirius is the last refuge of a theory in distress. The point is that the physical properties, size, and distance of Sirius do not seem to matter. The more natural deduction (on the theory of Newtonian relativity) is to look on the result as evidence that the theory of any empty space is an essential impossibility. Accordingly the absoluteness of direction is evidence for the existence of the material ether. This result only reinforces a conclusion which has already been reached on other grounds. Thus space expresses mutual relations of the parts of the ether, as well as of the parts of the earth.

9. Motion through the Ether. 9·1. The existence of the material ether should discriminate between the consentient sets of the Newtonian group. For one such set will be at rest relatively to the ether, and the remaining sets will be moving through it with definite velocities. It becomes a problem to discover phenomena dependent on such velocities.

Can any phenomena be detected which are unequivocally due to a quasi-absolute motion of the earth through the ether? For this purpose we must put aside phenomena which depend on the differential velocities of two bodies of matter, e.g. the earth and a planet, or a star. For such phenomena are evidently primarily due to the relative velocity of the two bodies to each other, and the velocities relatively to the ether only arise as a hypothetical intermediate explanatory analysis. We require phenomena concerned solely with the earth, which are modified by the earth's motion through the ether without reference to any other matter. We have already concluded that the bulging of the earth at the equator is one such required instance, unless indeed (with Newton) we assume absolute space.

9·2. The effects on the observed light due to the relative motions of the emitting body and the receiving body are various and depend in part on the specific nature of the assumed disturbances which constitute light. Some of these effects have been observed, for example, aberration

and the effect on the spectrum due to the motion of the emitting body in the line of sight. Aberration is the apparent change in the direction of the luminous body due to the motion of the receiving body. The motion of the luminous body in the line of sight should alter the wave length of the emitted light due to molecular vibrations of given periodicity. In other words, it should alter the quality of the light due to such vibrations. These are the effects which have been observed, but they are of the type which we put aside as not relevant to our purpose owing to the fact that the observed effect ultimately depends merely on the relative motion of the emitting and receiving bodies.

9·3. There are effects on interference fringes which we should expect to be due to the motion of the earth. In six months the velocity of the earth in its orbit is reversed. So that such effects as the earth's motion produces in the interference fringes of a certain purely terrestrial apparatus at one time can be compared with the corresponding effects in the same apparatus which it produces after the lapse of six months and—as the experiments have been carried out—the differences should have been easily discernible. No such differences have been observed. The effects, which are thus sought for, depend on no special theory of the nature of the luminous disturbance in the ether. They should result from the simple fact of the wave disturbance, and the magnitude of its velocity relatively to the apparatus.

It will be observed that the difficulty which arises from the absence of this predicted effect does not discriminate in any way between the philosophic theories of absolute or of relative space. The effect should arise from the motion of the earth relatively to the ether, and there is such relative motion whichever of the alternative spatial theories be adopted.

9·4. Electromagnetic phenomena are also implicated in the theory of relative motion. Maxwell's equations of the electromagnetic field hold in respect to these phenomena an analogous position to that occupied by Newton's equations of motion for the explanation of the motion of matter. They differ from Newton's equations very essentially in their relation to the principle of relativity. Newton's equations single out no special member of the Newtonian group to which they specially apply. They are invariant for the spatio-temporal transformations from one such set to another within the Newtonian group.

But Maxwell's electromagnetic equations are not thus invariant for the Newtonian group. The result is that they must be construed as

referring to one particular consentient set of this group. It is natural to suppose that this particular assumption arises from the fact that the equations refer to the physical properties of a stagnant ether; and that accordingly the consentient set presupposed in the equations is the consentient set of this ether. The ether is identified with the ether whose wave disturbances constitute light; and furthermore there are practically conclusive reasons for believing light to be merely electromagnetic disturbances which are governed by Maxwell's equations.

The motion of the earth through the ether affects other electromagnetic phenomena in addition to those known to us as light. Such effects, as also in the case of light, would be very small and difficult to observe. But the effect on the capacity of a condenser of the six-monthly reversal of the earth's velocity should under proper conditions be observable. This is known as Trouton's experiment. Again, as in the analogous case of light, no such effect has been observed.

9·5. The explanation [the Fitzgerald-Lorentz hypothesis] of these failures to observe expected effects has been given, that matter as it moves through ether automatically readjusts its shape so that its lengths in the direction of motion are altered in a definite ratio dependent on its velocity. The null results of the experiments are thus completely accounted for, and the material ether evades the most obvious method of testing its existence. If matter is thus strained by its passage through ether, some effect on its optical properties due to the strains might be anticipated. Such effects have been sought for, but not observed. Accordingly with the assumption of an ether of material the negative results of the various experiments are explained by an *ad hoc* hypothesis which appears to be related to no other phenomena in nature.

9·6. There is another way in which the motion of matter may be balanced (so to speak) against the velocity of light. Fizeau experimented on the passage of light through translucent moving matter, and obtained results which Fresnel accounted for by multiplying the refractive index of the moving medium by a coefficient dependent on its velocity. This is Fresnel's famous 'coefficient of drag.' He accounted for this coefficient by assuming, that as the material medium in its advance sucks in the ether, it condenses it in a proportion dependent on the velocity. It might be expected that any theory of the relations of matter to ether, either an ether of material or an ether of events, would explain also this coefficient of drag.

10. Formulae for Relative Motion. 10·1. In transforming the equa-

tions of motion from the space of one member of the Newtonian group to the space of another member of that group, it must be remembered that the facts which are common to the two standpoints are the events, and that the ideally simple analysis exhibits events as dissected into collections of event-particles. Thus if α and β be the two consentient sets, the points of the α-space are distinct from the points of the β-space, but the same event-particle e is at the point P_α at the time T_α in the α-space and is at the point P_β at the time T_β in the β-space.

With the covert assumption of absolute space which is habitual in the traditional outlook, it is tacitly assumed that P_α and P_β are the same point and that there is a common time and common measurement of time which are the same for all consentient sets. The first assumption is evidently very badly founded and cannot easily be reconciled to the nominal scientific creed; the second assumption seems to embody a deeply rooted experience. The corresponding formulae of transformation which connect the measurements of space, velocity, and acceleration in the α-system for space and time with the corresponding measurements in the β-system certainly are those suggested by common sense and in their results they agree very closely with the result of careful observation. These formulae are the ordinary formulae of dynamical treatises. For such transformations the Newtonian equations are invariant within the Newtonian group.

10·2. But, as we have seen, this invariance, with these formulae for transformation, does not extend to Maxwell's equations for the electromagnetic field. The conclusion is that—still assuming these formulae for transformation—Maxwell's equations apply to the electromagnetic field as referred to one particular consentient set of the Newtonian group. It is natural to suppose that this set should be that one with respect to which the stagnant ether is at rest. Namely, stating the same fact conversely, the stagnant ether defines this consentient set. There would be no difficulty about this conclusion except for the speculative character of the material ether, and the failure to detect the evidences of the earth's motion through it. This consentient set defined by the ether would for all practical purposes define absolute space.

10·3. There are however other formulae of transformation from the space and time measurements of set α to the space and time measurements of set β for which Maxwell's equations are invariant. These formulae were discovered first by Larmor for uncharged regions of the

field and later by Lorentz for the general case of regions charged or uncharged. Larmor and Lorentz treated their discovery from its formal mathematical side. This aspect of it is important. It enables us, when we thoroughly understand the sequence of events in one electromagnetic field, to deduce innumerable other electromagnetic fields which will be understood equally well. All mathematicians will appreciate what an advance in knowledge this constitutes.

But Lorentz also pointed out that if these formulae for transformation could be looked on as the true formulae for transformation from one set to another of the Newtonian group, then all the unsuccessful experiments to detect the earth's motion through the ether could be explained. Namely, the results of the experiments are such as theory would predict.

10·4. The general reason for this conclusion was given by Einstein in a theorem of the highest importance. He proved that the Lorentzian formulae of transformation from one consentient set to another of the Newtonian group—from set α to set β—are the necessary and sufficient conditions that motion with the one particular velocity c (the velocity of light *in vacuo*) in one of the sets, α or β, should also appear as motion with the same magnitude c in the other set, β or α. The phenomena of aberration will be preserved owing to the relation between the directions of the velocity expressing the movements in α-space and β-space respectively. This preservation of the magnitude of a special velocity (however directed) cannot arise with the traditional formulae for relativity. It practically means that waves or other influences advancing with velocity c as referred to the space of any consentient set of the Newtonian group will also advance with the same velocity c as referred to the space of any other such set.

10·5. At first sight the two formulae for transformation, namely the traditional formulae and the Lorentzian formulae, appear to be very different. We notice however that, if α and β be the two consentient sets and if $V_{\alpha\beta}$ be the velocity of β in the α-space and of α in the β-space, the differences between the two formulae all depend upon the square of the ratio of $V_{\alpha\beta}$ to c, where c is the velocity of light *in vacuo*, and are negligible in proportion to the smallness of this number. For ordinary motions, even planetary motions, this ratio is extremely small and its square is smaller still. Accordingly the differences between the two formulae would not be perceptible under ordinary circumstances. In

fact the effect of the difference would only be perceived in those experiments, already discussed, whose results have been in entire agreement with the Lorentzian formulae.

The conclusion at once evokes the suggestion that the Lorentzian formulae are the true formulae for transformation from the space and time relations of a consentient set α to those of a consentient set β, both sets belonging to the Newtonian group. We may suppose that, owing to bluntness of perception, mankind has remained satisfied with the Newtonian formulae which are a simplified version of the true Lorentzian relations. This is the conclusion that Einstein has urged.

Fig. 2.

10·6. These Lorentzian formulae for transformation involve two consequences which are paradoxical if we covertly assume absolute space and absolute time. Let α and β be two consentient sets of the Newtonian group. Let an event-particle P happen at the point P_α in the α-space and at the point P_β in the β-space, and let another event-particle Q happen at points Q_α and Q_β in the two spaces respectively. Then according to the traditional scientific outlook, P_α and P_β are not discriminated from each other; and similarly for Q_α and Q_β. Thus evidently the distance $P_\alpha Q_\alpha$ is (on this theory) equal to $P_\beta Q_\beta$, because in fact they are symbols for the same distance. But if the true distinction between the α-space and the β-space is kept in mind, including the fact that the points in the two spaces are radically distinct, the equality of the distances $P_\alpha Q_\alpha$ and $P_\beta Q_\beta$ is not so obvious. According to the Lorentzian formulae such corresponding distances in the two spaces will not in general be equal.

The second consequence of the Lorentzian formulae involves a more deeply rooted paradox which concerns our notions of time. If the two event-particles P and Q happen simultaneously when referred to the points P_α and Q_α in the α-space, they will in general not happen simultaneously when referred to the points P_β and Q_β in the β-space. This result of the Lorentzian formulae contradicts the assumption of one

absolute time, and makes the time-system depend on the consentient set which is adopted as the standard of reference. Thus there is an α-time as well as an α-space, and a β-time as well as a β-space.

10·7. The explanation of the similarities and differences between spaces and times derived from different consentient sets of the Newtonian group, and of the fact of there being a Newtonian group at all, will be derived in Parts II and III of this enquiry from a consideration of the general characteristics of our perceptive knowledge of nature, which is our whole knowledge of nature. In seeking such an explanation one principle may be laid down. Time and space are among the fundamental physical facts yielded by our knowledge of the external world. We cannot rest content with any theory of them which simply takes mathematical equations involving four variables (x, y, z, t) and interprets (x, y, z) as space coordinates and t as a measure of time, merely on the ground that some physical law is thereby expressed. This is not an interpretation of what we *mean* by space and time. What we mean are physical facts expressible in terms of immediate perceptions; and it is incumbent on us to produce the perceptions of those facts as the meanings of our terms.

Einstein has interpreted the Lorentzian formulae in terms of what we will term the 'message' theory, discussed in the next chapter.

APPENDIX TO CHAPTER III

Let α and β be two consentient sets of the Newtonian group. Let $(O_\alpha X_\alpha Y_\alpha Z_\alpha)$ be the rectangular axis system in the space of α, and $(O_\beta' X_\beta' Y_\beta' Z_\beta')$ be the rectangular axis system in the space of β.

First consider the traditional theory of relativity. Then the time-system is independent of the consentient set of reference.

At the time t let the event-particle which instantaneously happens at the point O_α in the space of α happen at O_β in the space of β, and let the event-particle which happens at O_β' in the space of β happen at O_α' in the space of α. Let the axis $O_\alpha X_\alpha$ be in the direction of the motion of β in the α-space, and the axis $O_\beta' X_\beta'$ be in the direction reversed of the motion of α in the β-space. Also let O_β' be so chosen that O_α' lies on $O_\alpha X_\alpha$. Then the event-particles at the instant t which happen on $O_\alpha X_\alpha$ are the event-particles which happen at the instant t on $O_\beta' X_\beta'$. Also we choose $O_\beta' Y_\beta'$ and $O_\beta' Z_\beta'$ so that the event-particles which

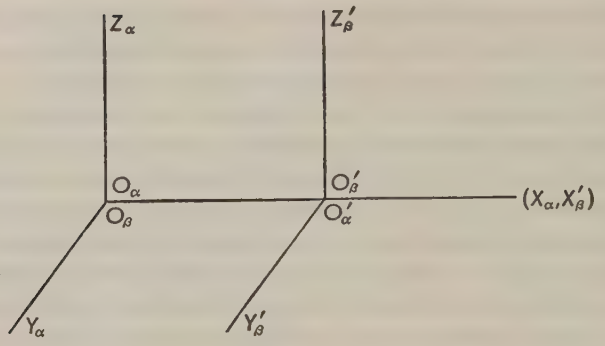


Fig. 3.

happen at time t on $O_\beta' Y_\beta'$ and $O_\beta' Z_\beta'$ respectively happen on straight lines in the α-space which are parallel to $O_\alpha Y_\alpha$ and $O_\alpha Z_\alpha$. Let $V_{\alpha\beta}$ be the velocity of β in α-space and $V_{\beta\alpha}$ be the velocity of α in β-space. Then (with a suitable origin of time)

$$\left.\begin{aligned} &V_{\alpha\beta} + V_{\beta\alpha} = 0, \\ &O_\alpha O_\alpha' = O_\beta O_\beta', \\ &x_\alpha = x_\beta + V_{\alpha\beta} t,\ y_\alpha = y_\beta,\ z_\alpha = z_\beta. \end{aligned}\right\} \quad \ldots\ldots (1)$$

These are the 'Newtonian' formulae for relative motion.

Secondly consider the Lorentzian [or 'electromagnetic'] theory of relativity. The two time-systems for reference to α and for reference to β respectively are not identical. Let t_α be the measure of the lapse of time in the α-system, and t_β be the measure of the lapse of time in the β-system. The distinction between the two time-systems is embodied in the fact that event-particles which happen simultaneously at time t_α in α-space do not happen simultaneously throughout space β. Thus supposing that an event-particle happens at $(x_\alpha, y_\alpha, z_\alpha, t_\alpha)$ in α-space and α-time and at $(x_\beta, y_\beta, z_\beta, t_\beta)$ in β-space and β-time, we seek for the formulae which are to replace equations (1) of the Newtonian theory.

As before let $O_\alpha X_\alpha$ lie in the direction of the motion of β in α, and $O_\beta' X_\beta'$ in the reverse direction of the motion of α in β. Also let O_α' lie on $O_\alpha X_\alpha$, so that event-particles which happen on $O_\alpha X_\alpha$ also happen on $O_\beta' X_\beta'$. One connection between the two time-systems is secured by the rule that event-particles which happen simultaneously at points in α-

space on a plane perpendicular to $O_\alpha X_\alpha$ also happen simultaneously at points in β-space on a plane perpendicular to $O_\beta' X_\beta'$. Accordingly the quasi-parallelism of $O_\alpha Y_\alpha$ to $O_\beta' Y_\beta'$, and of $O_\alpha Z_\alpha$ to $O_\beta' Z_\beta'$, is defined and secured in the same way as for Newtonian relativity.

The same meaning as above will be given to $V_{\alpha\beta}$ and $V_{\beta\alpha}$; also c is the fundamental velocity which is the velocity of light *in vacuo*. Then we define

$$\Omega_{\alpha\beta} = \Omega_{\beta\alpha} = (1 - V_{\alpha\beta}^2/c^2)^{-\frac{1}{2}}. \quad \ldots\ldots\ldots (2)$$

The formulae for transformation are

$$\left.\begin{aligned} &V_{\alpha\beta} + V_{\beta\alpha} = 0, \\ &t_\beta = \Omega_{\alpha\beta}\,(t_\alpha - V_{\alpha\beta}x_\alpha/c^2), \\ &x_\beta = \Omega_{\alpha\beta}\,(x_\alpha - V_{\alpha\beta}t_\alpha), \\ &y_\beta = y_\alpha,\ z_\beta = z_\alpha. \end{aligned}\right\} \quad \ldots\ldots\ldots (3)$$

These formulae are symmetrical as between α and β, so that

$$\left.\begin{aligned} t_\alpha &= \Omega_{\beta\alpha}\,(t_\beta - V_{\beta\alpha}x_\beta/c^2), \\ x_\alpha &= \Omega_{\beta\alpha}\,(x_\beta - V_{\beta\alpha}t_\beta). \end{aligned}\right\} \quad \ldots\ldots\ldots (4)$$

It is evident that when $V_{\alpha\beta}/c$ is small,

$$\Omega_{\alpha\beta} = \Omega_{\beta\alpha} = 1,$$

and when x_α and x_β are not too large

$$\begin{aligned} t_\beta &= t_\alpha, \\ x_\beta &= x_\alpha - V_{\alpha\beta}t_\alpha. \end{aligned}$$

Thus the formulae reduce to the Newtonian type.

Let $\dot{x}_\alpha$, $\dot{y}_\alpha$, $\dot{z}_\alpha$ stand for $\dfrac{dx_\alpha}{dt_\alpha}$, etc., and $\dot{x}_\beta$, $\dot{y}_\beta$, $\dot{z}_\beta$ for $\dfrac{dx_\beta}{dt_\beta}$, etc.

Then it follows immediately from the preceding formulae that

$$\left.\begin{aligned} \dot{x}_\beta &= (\dot{x}_\alpha - V_{\alpha\beta}) \Big/ \left(1 - \frac{V_{\alpha\beta}\dot{x}_\alpha}{c^2}\right), \\ \dot{y}_\beta &= \Omega_{\alpha\beta}^{-1}\dot{y}_\alpha \Big/ \left(1 - \frac{V_{\alpha\beta}\dot{x}_\alpha}{c^2}\right), \\ \dot{z}_\beta &= \Omega_{\alpha\beta}^{-1}\dot{z}_\alpha \Big/ \left(1 - \frac{V_{\alpha\beta}\dot{x}_\alpha}{c^2}\right). \end{aligned}\right\} \quad \ldots\ldots (5)$$

With the notation of Appendix II to Chapter II, the formulae of transformation for Maxwell's equations are

$$\left.\begin{aligned} F_\beta &= F_\alpha, \\ G_\beta &= \Omega_{\alpha\beta}\left(G_\alpha - \frac{V_{\alpha\beta}}{c} N_\alpha\right), \\ H_\beta &= \Omega_{\alpha\beta}\left(H_\alpha + \frac{V_{\alpha\beta}}{c} M_\alpha\right); \end{aligned}\right\} \quad \ldots\ldots\ldots (6)$$

and

$$\left.\begin{aligned} L_\beta &= L_\alpha, \\ M_\beta &= \Omega_{\alpha\beta}\left(M_\alpha + \frac{V_{\alpha\beta}}{c} H_\alpha\right), \\ N_\beta &= \Omega_{\alpha\beta}\left(N_\alpha - \frac{V_{\alpha\beta}}{c} G_\alpha\right); \end{aligned}\right\} \quad \ldots\ldots\ldots (7)$$

and

$$\rho_\beta = \Omega_{\alpha\beta}\rho_\alpha\left(1 - \frac{V_{\alpha\beta}u_\alpha}{c^2}\right), \quad \ldots\ldots\ldots (8)$$

where $(u_\alpha, v_\alpha, w_\alpha)$ is the velocity of the charge at $(x_\alpha, y_\alpha, z_\alpha)$ at the time t_α.

Also it immediately follows from formulae (5) that

$$\Omega_{\alpha\beta}{}^2(\dot{x}_\beta{}^2 + \dot{y}_\beta{}^2 + \dot{z}_\beta{}^2 - c^2) = (\dot{x}_\alpha{}^2 + \dot{y}_\alpha{}^2 + \dot{z}_\alpha{}^2 - c^2) \Big/ \left(1 - \frac{V_{\alpha\beta}\dot{x}_\alpha}{c^2}\right)^2.$$

Hence

$$(\dot{x}_\beta{}^2 + \dot{y}_\beta{}^2 + \dot{z}_\beta{}^2 - c^2) \text{ and } (x_\alpha{}^2 + \dot{y}_\alpha{}^2 + \dot{z}_\alpha{}^2 - c^2)$$

vanish together. This proves Einstein's theorem on the invariance of the velocity c, so far as concerns the sufficiency of the Lorentzian formulae to produce that result.

CHAPTER IV *CONGRUENCE*

11. Simultaneity. 11·1. Einstein analysed the ideas of time-order and of simultaneity. Primarily (according to his analysis) time-order only refers to the succession of events at a given place. Accordingly each given place has its own time-order. But these time-orders are not independent in the system of nature, and their correlation is known to us by means of physical measurements. Now ultimately all physical

measurement depends upon coincidence in time and place. If P_1 and P_2 be two places, the time-orders O_1 and O_2 which belong to P_1 and P_2 are correlated by observations of coincidences at P_1 and at P_2 respectively.

Thus, confining ourselves to the two places P_1 and P_2, there are two distinct processes of correlating the time-order of events throughout the universe, namely by a series of observations of coincidences at P_1 based on time-order O_1 and by a series of observations of coincidences at P_2 based on time-order O_2. These two processes are distinct and will only agree by some accident of special circumstance.

11·2. What are the observations at P_1 which will assign to an event at P_2 a position in the time-order O_1? Suppose some message—a wave disturbance, for example—starts from P_1 when event e_1 happens at P_1, reaches P_2 when event e_2 happens at P_2, and is immediately reflected so as to return to P_1 when event e_1'' happens at P_1. Now according to the method of time-measurement for O_1, there is an event e_1' which happens at mid-time between e_1 and e_1''. Then, when certain conditions have been fulfilled, the event e_2 at P_2 is defined as simultaneous with the event e_1' at P_1 according to the method of correlation appropriate to place P_1. In this way a time-order of events at P_2 is derived solely from observation of coincidence at P_1 and is based solely on the fundamental time-order O_1 at P_1. Thus the time-order at P_1 is extended as a time-order for all events at all places.

11·3. There are questions which require elucidation before this definition can be understood. What is a place? We have chosen a vague term on purpose, so as to postpone its consideration until now. A place can only be marked by phenomena capable of recognition, for example the continued appearance of a material body. Thus we must construe P_1 and P_2 to be the names of material bodies, or of persistent sets of circumstances which will serve the same purpose. In general P_1 and P_2 will be in relative motion with respect to each other.

What of the message which passes from P_1 to P_2 and back to P_1? Its transmission must be uniform. Suppose the message travels with velocity c, that is, with the velocity of light *in vacuo*. Then, assuming the electromagnetic formulae for relativity, this velocity relative to P_1 is independent (so far as its magnitude is concerned) of the velocity which we ascribe to P_1 through space.

11·4. Thus our recording body P_1 can be any body at rest in some consentient set of the Newtonian group, and we reckon motion as

relative to the space of this set. We send our message with the velocity of light *in vacuo*. Then, according to the local time-order O_1 at P_1, the event e_2 at P_2 is simultaneous with the event e_1' at P_1. This definition of simultaneity in the local time-order at P_1 is independent of any assumption of absolute rest for P_1, provided that the electromagnetic formulae for relativity are adopted. The local time-order at P_1 is also in complete agreement with the local time-order at any body Q_1 which is rigidly connected with P_1, i.e. which belongs to the same consentient set.

11·5. The reason why the velocity of light has been adopted as the standard velocity in the definition of simultaneity is because the negative results of the experiments to determine the earth's motion require that this velocity, which is the 'c' of Maxwell's equations, should have this property. Also light signals are after all our only way of detecting distant events.

Certainly, once granting the idea of time-order being a local affair connected with a specific body P_1, the acceptance of the electromagnetic formula connecting t_α and t_β is a slight affair. There is no presumption against it, once granting the conception of diverse time-orders which had not hitherto been thought of.

11·6. But there are certain objections to the acceptance of Einstein's definition of simultaneity, the 'signal-theory' as we will call it. In the first place light signals are very important elements in our lives, but still we cannot but feel that the signal-theory somewhat exaggerates their position. The very meaning of simultaneity is made to depend on them. There are blind people and dark cloudy nights, and neither blind people nor people in the dark are deficient in a sense of simultaneity. They know quite well what it means to bark both their shins at the same instant. In fact the determination of simultaneity in this way is never made, and if it could be made would not be accurate; for we live in air and not *in vacuo*.

Also there are other physical messages from place to place; there is the transmission of material bodies, the transmission of sound, the transmission of waves and ripples on the surface of water, the transmission of nerve excitation through the body, and innumerable other forms which enter into habitual experience. The transmission of light is only one form among many.

Furthermore local time does not concern one material particle only. The same definition of simultaneity holds throughout the whole space of a consentient set in the Newtonian group. The message theory does

not account for the consentience in time-reckoning which characterises a consentient set, nor does it account for the fundamental position of the Newtonian group.

12. Congruence and Recognition. 12·1. Again the theory that measurement is essentially coincidence requires severe qualification. For if it were true only coincident things, coincident both in time and space, could be equal, yet measurement can only be of the slightest importance in so far as some other element not coincidence enters into it.

Let us take a simple example. Two footrules are placed together and are found to coincide. Then at the moment of coincidence they are equal in length. But what is the use of that information? We want to use one rule to-morrow in London and the other rule a week hence in Manchester, and to know that the stuffs which they measure are of equal length. Now we know that, provided they are made of certain sorts of material (luckily, materials easy to procure) and treated with certain precautions (luckily, precautions easy to observe), the footrules will not have altered their lengths to any extent which can be detected. But that means a direct judgment of constancy. Without such a judgment in some form or other, measurement becomes trivial.

12·2. It may be objected that whenever the footrules are brought together, or when stuffs measured by them are brought together, the coincidences will be observed; and that this is all we need for the importance of measurement.

But the coincidences will not be observed unless the circumstances of the various experiments are sufficiently uniform. The stuffs must be under the same tension or at the same temperatures as on previous occasions. Sooner or later and somehow or other a judgment of constancy, that is, of the preservation of property, is required. Ultimately this judgment reposes upon direct common sense; namely, obviously the footrule is of good stiff material and has not perceptibly changed amid slight differences of circumstance. The coincidences which can easily be obtained between lengths of elastic thread inspire no such beliefs, because evidently the thread has been stretched.

12·3. Again, in Einstein's own example, there is the direct judgment of the uniformity of conditions for the uniform transmission of light. Thus any ordinary event among the fixed stars does not affect this uniformity for the transmission from the sun to the earth. Apart from such presuppositions, so obvious that they do not enter into consciousness, the whole theory collapses.

12·4. These judgments of constancy are based on an immediate comparison of circumstances at different times and at different places. Such judgments are not infallible and are capable of being tested under certain circumstances. For example it may be judged that two footrules would coincide if they were brought together; and this experiment can be made, and the judgment tested.

The rejection of an immediate judgment of constancy is no paradox. There are differences between any distinct sets of circumstances, and it is always possible that these differences cut deeper than we have perceived so as to produce unsuspected divergences of properties.

But a judgment of constancy is recognition, and recognition is the source of all our natural knowledge. Accordingly though isolated judgments may be rejected, it is essential that a rational consideration of nature should assume the truth of the greater part of such judgments and should issue in theories which embody them.

12·5. This recognition of congruity between distinct circumstances has no especial connection with coincidence and extends far beyond the mere judgments of time and space. Thus judgments of the matching of colours can be made without coincidence by most people to some slight extent, and by some people with surprising accuracy. It may be urged that only in the case of judgments of spatial and temporal coincidence can great accuracy be obtained. This may be true; but complete accuracy is never obtained, and the ideal of accuracy shows that the meaning is not derived from the measurement. Our recognitions are the ultimate facts of nature for science, and the whole scientific theory is nothing else than an attempt to systematise our knowledge of the circumstances in which such recognitions will occur. The theory of congruence is one branch of the more general theory of recognitions. Another branch is the theory of objects which is considered in the next part of this enquiry.

The Concept of Nature

Chapter I	Nature and Thought	199
Chapter II	Theories of the Bifurcation of Nature	216
Chapter III	Time	232
Chapter IV	The Method of Extensive Abstraction	249
Chapter V	Space and Motion	266
Chapter VII	Objects	280

CHAPTER I *NATURE AND THOUGHT*

The subject-matter of the Tarner lectures is defined by the founder to be 'the Philosophy of the Sciences and the Relations or Want of Relations between the different Departments of Knowledge.' It is fitting at the first lecture of this new foundation to dwell for a few moments on the intentions of the donor as expressed in this definition; and I do so the more willingly as I shall thereby be enabled to introduce the topics to which the present course is to be devoted.

We are justified, I think, in taking the second clause of the definition as in part explanatory of the earlier clause. What is the philosophy of the sciences? It is not a bad answer to say that it is the study of the relations between the different departments of knowledge. Then with admirable solicitude for the freedom of learning there is inserted in the definition after the word 'relations' the phrase 'or want of relations.' A disproof of relations between sciences would in itself constitute a philosophy of the sciences. But we could not dispense either with the earlier or the later clause. It is not every relation between sciences which enters into their philosophy. For example biology and physics are connected by the use of the microscope. Still, I may safely assert that a technical description of the uses of the microscope in biology is not part of the philosophy of the sciences. Again, you cannot abandon the later clause of the definition; namely that referring to the relations between the sciences, without abandoning the explicit reference to an ideal in the absence of which philosophy must languish from lack of intrinsic interest. That ideal is the attainment of some unifying concept which will set in assigned relationships within itself all that there is for knowledge, for feeling, and for emotion. That far off ideal is the motive power of philosophic research; and claims allegiance even as you expel it. The philosophic pluralist is a strict logician; the Hegelian thrives on contradictions by the help of his absolute; the Mohammedan divine bows before the creative will of Allah; and the pragmatist will swallow anything so long as it 'works.'

The mention of these vast systems and of the agelong controversies from which they spring, warns us to concentrate. Our task is the

simpler one of the philosophy of the sciences. Now a science has already a certain unity which is the very reason why that body of knowledge has been instinctively recognised as forming a science. The philosophy of a science is the endeavour to express explicitly those unifying characteristics which pervade that complex of thoughts and make it to be a science. The philosophy of the sciences—conceived as one subject—is the endeavour to exhibit all sciences as one science, or—in case of defeat—the disproof of such a possibility.

Again I will make a further simplification, and confine attention to the natural sciences, that is, to the sciences whose subject-matter is nature. By postulating a common subject-matter for this group of sciences a unifying philosophy of natural science has been thereby presupposed.

What do we mean by nature? We have to discuss the philosophy of natural science. Natural science is the science of nature. But—What is nature?

Nature is that which we observe in perception through the senses. In this sense-perception we are aware of something which is not thought and which is self-contained for thought. This property of being self-contained for thought lies at the base of natural science. It means that nature can be thought of as a closed system whose mutual relations do not require the expression of the fact that they are thought about.

Thus in a sense nature is independent of thought. By this statement no metaphysical pronouncement is intended. What I mean is that we can think about nature without thinking about thought. I shall say that then we are thinking 'homogeneously' about nature.

Of course it is possible to think of nature in conjunction with thought about the fact that nature is thought about. In such a case I shall say that we are thinking 'heterogeneously' about nature. In fact during the last few minutes we have been thinking heterogeneously about nature. Natural science is exclusively concerned with homogeneous thoughts about nature.

But sense-perception has in it an element which is not thought. It is a difficult psychological question whether sense-perception involves thought; and if it does involve thought, what is the kind of thought which it necessarily involves. Note that it has been stated above that sense-perception is an awareness of something which is not thought. Namely, nature is not thought. But this is a different

question, namely that the fact of sense-perception has a factor which is not thought. I call this factor 'sense-awareness.' Accordingly the doctrine that natural science is exclusively concerned with homogeneous thoughts about nature does not immediately carry with it the conclusion that natural science is not concerned with sense-awareness.

However, I do assert this further statement; namely, that though natural science is concerned with nature which is the terminus of sense-perception, it is not concerned with the sense-awareness itself.

I repeat the main line of this argument, and expand it in certain directions.

Thought about nature is different from the sense-perception of nature. Hence the fact of sense-perception has an ingredient or factor which is not thought. I call this ingredient sense-awareness. It is indifferent to my argument whether sense-perception has or has not thought as another ingredient. If sense-perception does not involve thought, then sense-awareness and sense-perception are identical. But the something perceived is perceived as an entity which is the terminus of the sense-awareness, something which for thought is beyond the fact of that sense-awareness. Also the something perceived certainly does not contain other sense-awarenesses which are different from the sense-awareness which is an ingredient in that perception. Accordingly nature as disclosed in sense-perception is self-contained as against sense-awareness, in addition to being self-contained as against thought. I will also express this self-containedness of nature by saying that nature is closed to mind.

This closure of nature does not carry with it any metaphysical doctrine of the disjunction of nature and mind. It means that in sense-perception nature is disclosed as a complex of entities whose mutual relations are expressible in thought without reference to mind, that is, without reference either to sense-awareness or to thought. Furthermore, I do not wish to be understood as implying that sense-awareness and thought are the only activities which are to be ascribed to mind. Also I am not denying that there are relations of natural entities to mind or minds other than being the termini of the sense-awarenesses of minds. Accordingly I will extend the meaning of the terms 'homogeneous thoughts' and 'heterogeneous thoughts' which have already been introduced. We are thinking 'homogeneously' about nature when we are thinking about it with-

out thinking about thought or about sense-awareness, and we are thinking 'heterogeneously' about nature when we are thinking about it in conjunction with thinking either about thought or about sense-awareness or about both.

I also take the homogeneity of thought about nature as excluding any reference to moral or aesthetic values whose apprehension is vivid in proportion to self-conscious activity. The values of nature are perhaps the key to the metaphysical synthesis of existence. But such a synthesis is exactly what I am not attempting. I am concerned exclusively with the generalisations of widest scope which can be effected respecting that which is known to us as the direct deliverance of sense-awareness.

I have said that nature is disclosed in sense-perception as a complex of entities. It is worth considering what we mean by an entity in this connexion. 'Entity' is simply the Latin equivalent for 'thing' unless some arbitrary distinction is drawn between the words for technical purposes. All thought has to be about things. We can gain some idea of this necessity of things for thought by examination of the structure of a proposition.

Let us suppose that a proposition is being communicated by an expositor to a recipient. Such a proposition is composed of phrases; some of these phrases may be demonstrative and others may be descriptive.

By a demonstrative phrase I mean a phrase which makes the recipient aware of an entity in a way which is independent of the particular demonstrative phrase. You will understand that I am here using 'demonstration' in the non-logical sense, namely in the sense in which a lecturer demonstrates by the aid of a frog and a microscope the circulation of the blood for an elementary class of medical students. I will call such demonstration 'speculative' demonstration, remembering Hamlet's use of the word 'speculation' when he says,

> There is no speculation in those eyes.

Thus a demonstrative phrase demonstrates an entity speculatively. It may happen that the expositor has meant some other entity—namely, the phrase demonstrates to him an entity which is diverse from the entity which it demonstrates to the recipient. In that case there is confusion; for there are two diverse propositions, namely

the proposition for the expositor and the proposition for the recipient. I put this possibility aside as irrelevant for our discussion, though in practice it may be difficult for two persons to concur in the consideration of exactly the same proposition, or even for one person to have determined exactly the proposition which he is considering.

Again the demonstrative phrase may fail to demonstrate any entity. In that case there is no proposition for the recipient. I think that we may assume (perhaps rashly) that the expositor knows what he means.

A demonstrative phrase is a gesture. It is not itself a constituent of the proposition, but the entity which it demonstrates is such a constituent. You may quarrel with a demonstrative phrase as in some way obnoxious to you; but if it demonstrates the right entity, the proposition is unaffected though your taste may be offended. This suggestiveness of the phraseology is part of the literary quality of the sentence which conveys the proposition. This is because a sentence directly conveys one proposition, while in its phraseology it suggests a penumbra of other propositions charged with emotional value. We are now talking of the one proposition directly conveyed in any phraseology.

This doctrine is obscured by the fact that in most cases what is in form a mere part of the demonstrative gesture is in fact a part of the proposition which it is desired directly to convey. In such a case we will call the phraseology of the proposition elliptical. In ordinary intercourse the phraseology of nearly all propositions is elliptical.

Let us take some examples. Suppose that the expositor is in London, say in Regent's Park and in Bedford College, the great women's college which is situated in that park. He is speaking in the college hall and he says,

'This college building is commodious.'

The phrase 'this college building' is a demonstrative phrase. Now suppose the recipient answers,

'This is not a college building, it is the lion-house in the Zoo.'

Then, provided that the expositor's original proposition has not been couched in elliptical phraseology, the expositor sticks to his original proposition when he replies,

'Anyhow, *it* is commodious.'

Note that the recipient's answer accepts the speculative demonstration of the phrase 'This college building.' He does not say, 'What do you mean?' He accepts the phrase as demonstrating an entity, but declares that same entity to be the lion-house in the Zoo. In his reply, the expositor in his turn recognises the success of his original gesture as a speculative demonstration, and waives the question of the suitability of its mode of suggestiveness with an 'anyhow.' But he is now in a position to repeat the original proposition with the aid of a demonstrative gesture robbed of any suggestiveness, suitable or unsuitable, by saying,

'*It* is commodious.'

The *'it'* of this final statement presupposes that thought has seized on the entity as a bare objective for consideration.

We confine ourselves to entities disclosed in sense-awareness. The entity is so disclosed as a relatum in the complex which is nature. It dawns on an observer because of its relations; but it is an objective for thought in its own bare individuality. Thought cannot proceed otherwise; namely, it cannot proceed without the ideal bare 'it' which is speculatively demonstrated. This setting up of the entity as a bare objective does not ascribe to it an existence apart from the complex in which it has been found by sense-perception. The 'it' for thought is essentially a relatum for sense-awareness.

The chances are that the dialogue as to the college building takes another form. Whatever the expositor originally meant, he almost certainly now takes his former statement as couched in elliptical phraseology, and assumes that he was meaning,

'This is a college building and is commodious.'

Here the demonstrative phrase or the gesture, which demonstrates the 'it' which is commodious, has now been reduced to 'this'; and the attenuated phrase, under the circumstances in which it is uttered, is sufficient for the purpose of correct demonstration. This brings out the point that the verbal form is never the whole phraseology of the proposition; this phraseology also includes the general circumstances of its production. Thus the aim of a demonstrative phrase is to exhibit a definite 'it' as a bare objective for thought; but the *modus operandi* of a demonstrative phrase is to produce an awareness of the entity as a particular relatum in an auxiliary complex, chosen merely for the sake of the speculative demonstration and irrelevant to the proposition. For example, in the above dialogue, colleges and

buildings, as related to the 'it' speculatively demonstrated by the phrase 'this college building,' set that 'it' in an auxiliary complex which is irrelevant to the proposition

'It is commodious.'

Of course in language every phrase is invariably highly elliptical. Accordingly the sentence

'This college building is commodious'

means probably

'This college building is commodious as a college building.'

But it will be found that in the above discussion we can replace 'commodious' by 'commodious as a college building' without altering our conclusion; though we can guess that the recipient, who thought he was in the lion-house of the Zoo, would be less likely to assent to

'Anyhow, it is commodious as a college building.'

A more obvious instance of elliptical phraseology arises if the expositor should address the recipient with the remark,

'That criminal is your friend.'

The recipient might answer,

'He is my friend and you are insulting.'

Here the recipient assumes that the phrase 'That criminal' is elliptical and not merely demonstrative. In fact, pure demonstration is impossible though it is the ideal of thought. This practical impossibility of pure demonstration is a difficulty which arises in the communication of thought and in the retention of thought. Namely, a proposition about a particular factor in nature can neither be expressed to others nor retained for repeated consideration without the aid of auxiliary complexes which are irrelevant to it.

I now pass to descriptive phrases. The expositor says,

'A college in Regent's Park is commodious.'

The recipient knows Regent's Park well. The phrase 'A college in Regent's Park' is descriptive for him. If its phraseology is not elliptical, which in ordinary life it certainly will be in some way or other, this proposition simply means,

'There is an entity which is a college building in Regent's Park and is commodious.'

If the recipient rejoins,

'The lion-house in the Zoo is the only commodious building in Regent's Park,'

he now contradicts the expositor, on the assumption that a lion-house in a Zoo is not a college building.

Thus whereas in the first dialogue the recipient merely quarrelled with the expositor without contradicting him, in this dialogue he contradicts him. Thus a descriptive phrase is part of the proposition which it helps to express, whereas a demonstrative phrase is not part of the proposition which it helps to express.

Again the expositor might be standing in Green Park—where there are no college buildings—and say,

'This college building is commodious.'

Probably no proposition will be received by the recipient because the demonstrative phrase,

'This college building'

has failed to demonstrate owing to the absence of the background of sense-awareness which it presupposes.

But if the expositor had said,

'A college building in Green Park is commodious,'

the recipient would have received a proposition, but a false one.

Language is usually ambiguous and it is rash to make general assertions as to its meanings. But phrases which commence with 'this' or 'that' are usually demonstrative, whereas phrases which commence with 'the' or 'a' are often descriptive. In studying the theory of propositional expression it is important to remember the wide difference between the analogous modest words 'this' and 'that' on the one hand and 'a' and 'the' on the other hand. The sentence

'The college building in Regent's Park is commodious' means, according to the analysis first made by Bertrand Russell, the proposition,

'There is an entity which (i) is a college building in Regent's Park and (ii) is commodious and (iii) is such that any college building in Regent's Park is identical with it.'

The descriptive character of the phrase 'The college building in Regent's Park' is thus evident. Also the proposition is denied by the denial of any one of its three component clauses or by the denial of any combination of the component clauses. If we had substituted 'Green Park' for 'Regent's Park' a false proposition would have resulted. Also the erection of a second college in Regent's Park

would make the proposition false, though in ordinary life common sense would politely treat it as merely ambiguous.

'The Iliad' for a classical scholar is usually a demonstrative phrase; for it demonstrates to him a well-known poem. But for the majority of mankind the phrase is descriptive, namely, it is synonymous with 'The poem named "the Iliad." '

Names may be either demonstrative or descriptive phrases. For example 'Homer' is for us a descriptive phrase, namely, the word with some slight difference in suggestiveness means 'The man who wrote the Iliad.'

This discussion illustrates that thought places before itself bare objectives, entities as we call them, which the thinking clothes by expressing their mutual relations. Sense-awareness discloses fact with factors which are the entities for thought. The separate distinction of an entity in thought is not a metaphysical assertion, but a method of procedure necessary for the finite expression of individual propositions. Apart from entities there could be no finite truths; they are the means by which the infinitude of irrelevance is kept out of thought.

To sum up: the termini for thought are entities, primarily with bare individuality, secondarily with properties and relations ascribed to them in the procedure of thought; the termini for sense-awareness are factors in the fact of nature, primarily relata and only secondarily discriminated as distinct individualities.

No characteristic of nature which is immediately posited for knowledge by sense-awareness can be explained. It is impenetrable by thought, in the sense that its peculiar essential character which enters into experience by sense-awareness is for thought merely the guardian of its individuality as a bare entity. Thus for thought 'red' is merely a definite entity, though for awareness 'red' has the content of its individuality. The transition from the 'red' of awareness to the 'red' of thought is accompanied by a definite loss of content, namely by the transition from the factor 'red' to the entity 'red.' This loss in the transition to thought is compensated by the fact that thought is communicable whereas sense-awareness is incommunicable.

Thus here are three components in our knowledge of nature, namely, fact, factors, and entities. Fact is the undifferentiated terminus of sense-awareness; factors are termini of sense-awareness,

differentiated as elements of fact; entities are factors in their function as the termini of thought. The entities thus spoken of are natural entities. Thought is wider than nature, so that there are entities for thought which are not natural entities.

When we speak of nature as a complex of related entities, the 'complex' is fact as an entity for thought, to whose bare individuality is ascribed the property of embracing in its complexity the natural entities. It is our business to analyse this conception and in the course of the analysis space and time should appear. Evidently the relations holding between natural entities are themselves natural entities, namely they are also factors of fact, there for sense-awareness. Accordingly the structure of the natural complex can never be completed in thought, just as the factors of fact can never be exhausted in sense-awareness. Unexhaustiveness is an essential character of our knowledge of nature. Also nature does not exhaust the matter for thought, namely there are thoughts which would not occur in any homogeneous thinking about nature.

The question as to whether sense-perception involves thought is largely verbal. If sense-perception involves a cognition of individuality abstracted from the actual position of the entity as a factor in fact, then it undoubtedly does involve thought. But if it is conceived as sense-awareness of a factor in fact competent to evoke emotion and purposeful action without further cognition, then it does not involve thought. In such a case the terminus of the sense-awareness is something for mind, but nothing for thought. The sense-perception of some lower forms of life may be conjectured to approximate to this character habitually. Also occasionally our own sense-perception in moments when thought-activity has been lulled to quiescence is not far off the attainment of this ideal limit.

The process of discrimination in sense-awareness has two distinct sides. There is the discrimination of fact into parts, and the discrimination of any part of fact as exhibiting relations to entities which are not parts of fact though they are ingredients in it. Namely the immediate fact for awareness is the whole occurrence of nature. It is nature as an event present for sense-awareness, and essentially passing. There is no holding nature still and looking at it. We cannot redouble our efforts to improve our knowledge of the terminus of our present sense-awareness; it is our subsequent opportunity in subsequent sense-awareness which gains the benefit of our good

resolution. Thus the ultimate fact for sense-awareness is an event. This whole event is discriminated by us into partial events. We are aware of an event which is our bodily life, of an event which is the course of nature within this room, and of a vaguely perceived aggregate of other partial events. This is the discrimination in sense-awareness of fact into parts.

I shall use the term 'part' in the arbitrarily limited sense of an event which is part of the whole fact disclosed in awareness.

Sense-awareness also yields to us other factors in nature which are not events. For example, sky-blue is seen as situated in a certain event. This relation of situation requires further discussion which is postponed to a later lecture. My present point is that sky-blue is found in nature with a definite implication in events, but is not an event itself. Accordingly in addition to events, there are other factors in nature directly disclosed to us in sense-awareness. The conception in thought of all the factors in nature as distinct entities with definite natural relations is what I have in another place * called the 'diversification of nature.'

There is one general conclusion to be drawn from the foregoing discussion. It is that the first task of a philosophy of science should be some general classification of the entities disclosed to us in sense-perception.

Among the examples of entities in addition to 'events' which we have used for the purpose of illustration are the buildings of Bedford College, Homer, and sky-blue. Evidently these are very different sorts of things; and it is likely that statements which are made about one kind of entity will not be true about other kinds. If human thought proceeded with the orderly method which abstract logic would suggest to it, we might go further and say that a classification of natural entities should be the first step in science itself. Perhaps you will be inclined to reply that this classification has already been effected, and that science is concerned with the adventures of material entities in space and time.

The history of the doctrine of matter has yet to be written. It is the history of the influence of Greek philosophy on science. That influence has issued in one long misconception of the metaphysical status of natural entities. The entity has been separated from the

* Cf. *Enquiry*.

factor which is the terminus of sense-awareness. It has become the substratum for that factor, and the factor has been degraded into an attribute of the entity. In this way a distinction has been imported into nature which is in truth no distinction at all. A natural entity is merely a factor of fact, considered in itself. Its disconnexion from the complex of fact is a mere abstraction. It is not the substratum of the factor, but the very factor itself as bared in thought. Thus what is a mere procedure of mind in the translation of sense-awareness into discursive knowledge has been transmuted into a fundamental character of nature. In this way matter has emerged as being the metaphysical substratum of its properties, and the course of nature is interpreted as the history of matter.

Plato and Aristotle found Greek thought preoccupied with the quest for the simple substances in terms of which the course of events could be expressed. We may formulate this state of mind in the question, What is nature made of? The answers which their genius gave to this question, and more particularly the concepts which underlay the terms in which they framed their answers, have determined the unquestioned presuppositions as to time, space and matter which have reigned in science.

In Plato the forms of thought are more fluid than in Aristotle, and therefore, as I venture to think, the more valuable. Their importance consists in the evidence they yield of cultivated thought about nature before it had been forced into a uniform mould by the long tradition of scientific philosophy. For example in the *Timaeus* there is a presupposition, somewhat vaguely expressed, of a distinction between the general becoming of nature and the measurable time of nature. In a later lecture I have to distinguish between what I call the passage of nature and particular time-systems which exhibit certain characteristics of that passage. I will not go so far as to claim Plato in direct support of this doctrine, but I do think that the sections of the *Timaeus* which deal with time become clearer if my distinction is admitted.

This is however a digression. I am now concerned with the origin of the scientific doctrine of matter in Greek thought. In the *Timaeus* Plato asserts that nature is made of fire and earth with air and water as intermediate between them, so that 'as fire is to air so is air to water, and as air is to water so is water to earth.' He also suggests

a molecular hypothesis for these four elements. In this hypothesis everything depends on the shape of the atoms; for earth it is cubical and for fire it is pyramidal. To-day physicists are again discussing the structure of the atom, and its shape is no slight factor in that structure. Plato's guesses read much more fantastically than does Aristotle's systematic analysis; but in some ways they are more valuable. The main outline of his ideas is comparable with that of modern science. It embodies concepts which any theory of natural philosophy must retain and in some sense must explain. Aristotle asked the fundamental question, What do we mean by 'substance'? Here the reaction between his philosophy and his logic worked very unfortunately. In his logic, the fundamental type of affirmative proposition is the attribution of a predicate to a subject. Accordingly, amid the many current uses of the term 'substance' which he analyses, he emphasises its meaning as 'the ultimate substratum which is no longer predicated of anything else.'

The unquestioned acceptance of the Aristotelian logic has led to an ingrained tendency to postulate a substratum for whatever is disclosed in sense-awareness, namely, to look below what we are aware of for the substance in the sense of the 'concrete thing.' This is the origin of the modern scientific concept of matter and of ether, namely they are the outcome of this insistent habit of postulation.

Accordingly ether has been invented by modern science as the substratum of the events which are spread through space and time beyond the reach of ordinary ponderable matter. Personally, I think that predication is a muddled notion confusing many different relations under a convenient common form of speech. For example, I hold that the relation of green to a blade of grass is entirely different from the relation of green to the event which is the life history of that blade for some short period, and is different from the relation of the blade to that event. In a sense I call the event the situation of the green, and in another sense it is the situation of the blade. Thus in one sense the blade is a character or property which can be predicated of the situation, and in another sense the green is a character or property of the same event which is also its situation. In this way the predication of properties veils radically different relations between entities.

Accordingly 'substance,' which is a correlative term to 'predica-

tion,' shares in the ambiguity. If we are to look for substance anywhere, I should find it in events which are in some sense the ultimate substance of nature.

Matter, in its modern scientific sense, is a return to the Ionian effort to find in space and time some stuff which composes nature. It has a more refined signification than the early guesses at earth and water by reason of a certain vague association with the Aristotelian idea of substance.

Earth, water, air, fire, and matter, and finally ether are related in direct succession so far as concerns their postulated characters of ultimate substrata of nature. They bear witness to the undying vitality of Greek philosophy in its search for the ultimate entities which are the factors of the fact disclosed in sense-awareness. This search is the origin of science.

The succession of ideas starting from the crude guesses of the early Ionian thinkers and ending in the nineteenth century ether reminds us that the scientific doctrine of matter is really a hybrid through which philosophy passed on its way to the refined Aristotelian concept of substance and to which science returned as it reacted against philosophic abstractions. Earth, fire, and water in the Ionic philosophy and the shaped elements in the *Timaeus* are comparable to the matter and ether of modern scientific doctrine. But substance represents the final philosophic concept of the substratum which underlies any attribute. Matter (in the scientific sense) is already in space and time. Thus matter represents the refusal to think away spatial and temporal characteristics and to arrive at the bare concept of an individual entity. It is this refusal which has caused the muddle of importing the mere procedure of thought into the fact of nature. The entity, bared of all characteristics except those of space and time, has acquired a physical status as the ultimate texture of nature; so that the course of nature is conceived as being merely the fortunes of matter in its adventure through space.

Thus the origin of the doctrine of matter is the outcome of uncritical acceptance of space and time as external conditions for natural existence. By this I do not mean that any doubt should be thrown on facts of space and time as ingredients in nature. What I do mean is 'the unconscious presupposition of space and time as being that within which nature is set.' This is exactly the sort of presupposition which tinges thought in any reaction against the subtlety of

philosophical criticism. My theory of the formation of the scientific doctrine of matter is that first philosophy illegitimately transformed the bare entity, which is simply an abstraction necessary for the method of thought, into the metaphysical substratum of these factors in nature which in various senses are assigned to entities as their attributes; and that, as a second step, scientists (including philosophers who were scientists) in conscious or unconscious ignoration of philosophy presupposed this substratum, *qua* substratum for attributes, as nevertheless in time and space.

This is surely a muddle. The whole being of substance is as a substratum for attributes. Thus time and space should be attributes of the substance. This they palpably are not, if the matter be the substance of nature, since it is impossible to express spatio-temporal truths without having recourse to relations involving relata other than bits of matter. I waive this point however, and come to another. It is not the substance which is in space, but the attributes. What we find in space are the red of the rose and the smell of the jasmine and the noise of cannon. We have all told our dentists where our toothache is. Thus space is not a relation between substances, but between attributes.

Thus even if you admit that the adherents of substance can be allowed to conceive substance as matter, it is a fraud to slip substance into space on the plea that space expresses relations between substances. On the face of it space has nothing to do with substances, but only with their attributes. What I mean is, that if you choose—as I think wrongly—to construe our experience of nature as an awareness of the attributes of substances, we are by this theory precluded from finding any analogous direct relations between substances as disclosed in our experience. What we do find are relations between the attributes of substances. Thus if matter is looked on as substance in space, the space in which it finds itself has very little to do with the space of our experience.

The above argument has been expressed in terms of the relational theory of space. But if space be absolute—namely, if it have a being independent of things in it—the course of the argument is hardly changed. For things in space must have a certain fundamental relation to space which we will call occupation. Thus the objection that it is the attributes which are observed as related to space, still holds.

The scientific doctrine of matter is held in conjunction with an

absolute theory of time. The same arguments apply to the relations between matter and time as apply to the relations between space and matter. There is however (in the current philosophy) a difference in the connexions of space with matter from those of time with matter, which I will proceed to explain.

Space is not merely an ordering of material entities so that any one entity bears certain relations to other material entities. The occupation of space impresses a certain character on each material entity in itself. By reason of its occupation of space matter has extension. By reason of its extension each bit of matter is divisible into parts, and each part is a numerically distinct entity from every other such part. Accordingly it would seem that every material entity is not really one entity. It is an essential multiplicity of entities. There seems to be no stopping this dissociation of matter into multiplicities short of finding each ultimate entity occupying one individual point. This essential multiplicity of material entities is certainly not what is meant by science, nor does it correspond to anything disclosed in sense-awareness. It is absolutely necessary that at a certain stage in this dissociation of matter a halt should be called, and that the material entities thus obtained should be treated as units. The stage of arrest may be arbitrary or may be set by the characteristics of nature; but all reasoning in science ultimately drops its space-analysis and poses to itself the problem, 'Here is one material entity, what is happening to it as a unit entity?' Yet this material entity is still retaining its extension, and as thus extended is a mere multiplicity. Thus there is an essential atomic property in nature which is independent of the dissociation of extension. There is something which in itself is one, and which is more than the logical aggregate of entities occupying points within the volume which the unit occupies. Indeed we may well be sceptical as to these ultimate entities at points, and doubt whether there are any such entities at all. They have the suspicious character that we are driven to accept them by abstract logic and not by observed fact.

Time (in the current philosophy) does not exert the same disintegrating effect on matter which occupies it. If matter occupies a duration of time, the whole matter occupies every part of that duration. Thus the connexion between matter and time differs from the connexion between matter and space as expressed in current scientific

philosophy. There is obviously a greater difficulty in conceiving time as the outcome of relations between different bits of matter than there is in the analogous conception of space. At an instant distinct volumes of space are occupied by distinct bits of matter. Accordingly there is so far no intrinsic difficulty in conceiving that space is merely the resultant of relations between the bits of matter. But in the one-dimensional time the same bit of matter occupies different portions of time. Accordingly time would have to be expressible in terms of the relations of a bit of matter with itself. My own view is a belief in the relational theory both of space and of time, and of disbelief in the current form of the relational theory of space which exhibits bits of matter as the relata for spatial relations. The true relata are events. The distinction which I have just pointed out between time and space in their connexion with matter makes it evident that any assimilation of time and space cannot proceed along the traditional line of taking matter as a fundamental element in space-formation.

The philosophy of nature took a wrong turn during its development by Greek thought. This erroneous presupposition is vague and fluid in Plato's *Timaeus*. The general groundwork of the thought is still uncommitted and can be construed as merely lacking due explanation and the guarding emphasis. But in Aristotle's exposition the current conceptions were hardened and made definite so as to produce a faulty analysis of the relation between the matter and the form of nature as disclosed in sense-awareness. In this phrase the term 'matter' is not used in its scientific sense.

I will conclude by guarding myself against a misapprehension. It is evident that the current doctrine of matter enshrines some fundamental law of nature. Any simple illustration will exemplify what I mean. For example, in a museum some specimen is locked securely in a glass case. It stays there for years: it loses its colour, and perhaps falls to pieces. But it is the same specimen; and the same chemical elements and the same quantities of those elements are present within the case at the end as were present at the beginning. Again the engineer and the astronomer deal with the motions of real permanences in nature. Any theory of nature which for one moment loses sight of these great basic facts of experience is simply silly. But it is permissible to point out that the scientific expression of

these facts has become entangled in a maze of doubtful metaphysics; and that, when we remove the metaphysics and start afresh on an unprejudiced survey of nature, a new light is thrown on many fundamental concepts which dominate science and guide the progress of research.

CHAPTER II *THEORIES OF THE BIFURCATION OF NATURE*

In my previous lecture I criticised the concept of matter as the substance whose attributes we perceive. This way of thinking of matter is, I think, the historical reason for its introduction into science, and is still the vague view of it at the background of our thoughts which makes the current scientific doctrine appear so obvious. Namely we conceive ourselves as perceiving attributes of things, and bits of matter are the things whose attributes we perceive.

In the seventeenth century the sweet simplicity of this aspect of matter received a rude shock. The transmission doctrines of science were then in process of elaboration and by the end of the century were unquestioned, though their particular forms have since been modified. The establishment of these transmission theories marks a turning point in the relation between science and philosophy. The doctrines to which I am especially alluding are the theories of light and sound. I have no doubt that the theories had been vaguely floating about before as obvious suggestions of common sense; for nothing in thought is ever completely new. But at that epoch they were systematised and made exact, and their complete consequences were ruthlessly deduced. It is the establishment of this procedure of taking the consequences seriously which marks the real discovery of a theory. Systematic doctrines of light and sound as being something proceeding from the emitting bodies were definitely established, and in particular the connexion of light with colour was laid bare by Newton.

The result completely destroyed the simplicity of the 'substance and attribute' theory of perception. What we see depends on the light entering the eye. Furthermore we do not even perceive what

enters the eye. The things transmitted are waves or—as Newton thought—minute particles, and the things seen are colours. Locke met this difficulty by a theory of primary and secondary qualities. Namely, there are some attributes of the matter which we do perceive. These are the primary qualities, and there are other things which we perceive, such as colours, which are not attributes of matter, but are perceived by us as if they were such attributes. These are the secondary qualities of matter.

Why should we perceive secondary qualities? It seems an extremely unfortunate arrangement that we should perceive a lot of things that are not there. Yet this is what the theory of secondary qualities in fact comes to. There is now reigning in philosophy and in science an apathetic acquiescence in the conclusion that no coherent account can be given of nature as it is disclosed to us in sense-awareness, without dragging in its relations to mind. The modern account of nature is not, as it should be, merely an account of what the mind knows of nature; but it is also confused with an account of what nature does to the mind. The result has been disastrous both to science and to philosophy, but chiefly to philosophy. It has transformed the grand question of the relations between nature and mind into the petty form of the interaction between the human body and mind.

Berkeley's polemic against matter was based on this confusion introduced by the transmission theory of light. He advocated, rightly as I think, the abandonment of the doctrine of matter in its present form. He had however nothing to put in its place except a theory of the relation of finite minds to the divine mind.

But we are endeavouring in these lectures to limit ourselves to nature itself and not to travel beyond entities which are disclosed in sense-awareness.

Percipience in itself is taken for granted. We consider indeed conditions for percipience, but only so far as those conditions are among the disclosures of perception. We leave to metaphysics the synthesis of the knower and the known. Some further explanation and defence of this position is necessary, if the line of argument of these lectures is to be comprehensible.

The immediate thesis for discussion is that any metaphysical interpretation is an illegitimate importation into the philosophy of natural science. By a metaphysical interpretation I mean any dis-

cussion of the how (beyond nature) and of the why (beyond nature) of thought and sense-awareness. In the philosophy of science we seek the general notions which apply to nature, namely, to what we are aware of in perception. It is the philosophy of the thing perceived, and it should not be confused with the metaphysics of reality of which the scope embraces both perceiver and perceived. No perplexity concerning the object of such knowledge can be solved by saying that there is a mind knowing it.*

In other words, the ground taken is this: sense-awareness is an awareness of something. What then is the general character of that something of which we are aware? We do not ask about the percipient or about the process, but about the perceived. I emphasise this point because discussions on the philosophy of science are usually extremely metaphysical—in my opinion, to the great detriment of the subject.

The recourse to metaphysics is like throwing a match into the powder magazine. It blows up the whole arena. This is exactly what scientific philosophers do when they are driven into a corner and convicted of incoherence. They at once drag in the mind and talk of entities in the mind or out of the mind as the case may be. For natural philosophy everything perceived is in nature. We may not pick and choose. For us the red glow of the sunset should be as much part of nature as are the molecules and electric waves by which men of science would explain the phenomenon. It is for natural philosophy to analyse how these various elements of nature are connected.

In making this demand I conceive myself as adopting our immediate instinctive attitude towards perceptual knowledge which is only abandoned under the influence of theory. We are instinctively willing to believe that by due attention, more can be found in nature than that which is observed at first sight. But we will not be content with less. What we ask from the philosophy of science is some account of the coherence of things perceptively known.

This means a refusal to countenance any theory of psychic additions to the object known in perception. For example, what is given in perception is the green grass. This is an object which we know as an ingredient in nature. The theory of psychic additions would

* Cf. *Enquiry*, preface.

treat the greenness as a psychic addition furnished by the perceiving mind, and would leave to nature merely the molecules and the radiant energy which influence the mind towards that perception. My argument is that this dragging in of the mind as making additions of its own to the thing posited for knowledge by sense-awareness is merely a way of shirking the problem of natural philosophy. That problem is to discuss the relations *inter se* of things known, abstracted from the bare fact that they are known. Natural philosophy should never ask, what is in the mind and what is in nature. To do so is a confession that it has failed to express relations between things perceptively known, namely to express those natural relations whose expression is natural philosophy. It may be that the task is too hard for us, that the relations are too complex and too various for our apprehension, or are too trivial to be worth the trouble of exposition. It is indeed true that we have gone but a very small way in the adequate formulation of such relations. But at least do not let us endeavour to conceal failure under a theory of the byplay of the perceiving mind.

What I am essentially protesting against is the bifurcation of nature into two systems of reality, which, in so far as they are real, are real in different senses. One reality would be the entities such as electrons which are the study of speculative physics. This would be the reality which is there for knowledge; although on this theory it is never known. For what is known is the other sort of reality, which is the byplay of the mind. Thus there would be two natures, one is the conjecture and the other is the dream.

Another way of phrasing this theory which I am arguing against is to bifurcate nature into two divisions, namely into the nature apprehended in awareness and the nature which is the cause of awareness. The nature which is the fact apprehended in awareness holds within it the greenness of the trees, the song of the birds, the warmth of the sun, the hardness of the chairs, and the feel of the velvet. The nature which is the cause of awareness is the conjectured system of molecules and electrons which so affects the mind as to produce the awareness of apparent nature. The meeting point of these two natures is the mind, the causal nature being influent and the apparent nature being effluent.

There are four questions which at once suggest themselves for discussion in connexion with this bifurcation theory of nature. They concern (i) causality, (ii) time, (iii) space, and (iv) delusions.

These questions are not really separable. They merely constitute four distinct starting points from which to enter upon the discussion of the theory.

Causal nature is the influence on the mind which is the cause of the effluence of apparent nature from the mind. This conception of causal nature is not to be confused with the distinct conception of one part of nature as being the cause of another part. For example, the burning of the fire and the passage of heat from it through intervening space is the cause of the body, its nerves and its brain, functioning in certain ways. But this is not an action of nature on the mind. It is an interaction within nature. The causation involved in this interaction is causation in a different sense from the influence of this system of bodily interactions within nature on the alien mind which thereupon perceives redness and warmth.

The bifurcation theory is an attempt to exhibit natural science as an investigation of the cause of the fact of knowledge. Namely, it is an attempt to exhibit apparent nature as an effluent from the mind because of causal nature. The whole notion is partly based on the implicit assumption that the mind can only know that which it has itself produced and retains in some sense within itself, though it requires an exterior reason both as originating and as determining the character of its activity. But in considering knowledge we should wipe out all these spatial metaphors, such as 'within the mind' and 'without the mind.' Knowledge is ultimate. There can be no explanation of the 'why' of knowledge; we can only describe the 'what' of knowledge. Namely we can analyse the content and its internal relations, but we cannot explain why there is knowledge. Thus causal nature is a metaphysical chimera; though there is need of a metaphysics whose scope transcends the limitation to nature. The object of such a metaphysical science is not to explain knowledge, but exhibit in its utmost completeness our concept of reality.

However, we must admit that the causality theory of nature has its strong suit. The reason why the bifurcation of nature is always creeping back into scientific philosophy is the extreme difficulty of exhibiting the perceived redness and warmth of the fire in one system of relations with the agitated molecules of carbon and oxygen, with the radiant energy from them, and with the various functionings of the material body. Unless we produce the all-embracing relations, we are faced with a bifurcated nature; namely, warmth and redness on

one side, and molecules, electrons and ether on the other side. Then the two factors are explained as being respectively the cause and the mind's reaction to the cause.

Time and space would appear to provide these all-embracing relations which the advocates of the philosophy of the unity of nature require. The perceived redness of the fire and the warmth are definitely related in time and in space to the molecules of the fire and the molecules of the body.

It is hardly more than a pardonable exaggeration to say that the determination of the meaning of nature reduces itself principally to the discussion of the character of time and the character of space. In succeeding lectures I shall explain my own view of time and space. I shall endeavour to show that they are abstractions from more concrete elements of nature, namely, from events. The discussion of the details of the process of abstraction will exhibit time and space as interconnected, and will finally lead us to the sort of connexions between their measurements which occur in the modern theory of electromagnetic relativity. But this is anticipating our subsequent line of development. At present I wish to consider how the ordinary views of time and space help, or fail to help, in unifying our conception of nature.

First, consider the absolute theories of time and space. We are to consider each, namely both time and space, to be a separate and independent system of entities, each system known to us in itself and for itself concurrently with our knowledge of the events of nature. Time is the ordered succession of durationless instants; and these instants are known to us merely as the relata in the serial relation which is the time-ordering relation, and the time-ordering relation is merely known to us as relating the instants. Namely, the relation and the instants are jointly known to us in our apprehension of time, each implying the other.

This is the absolute theory of time. Frankly, I confess that it seems to me to be very unplausible. I cannot in my own knowledge find anything corresponding to the bare time of the absolute theory. Time is known to me as an abstraction from the passage of events. The fundamental fact which renders this abstraction possible is the passing of nature, its development, its creative advance, and combined with this fact is another characteristic of nature, namely the extensive relation between events. These two facts, namely the passage of

events and the extension of events over each other, are in my opinion the qualities from which time and space originate as abstractions. But this is anticipating my own later speculations.

Meanwhile, returning to the absolute theory, we are to suppose that time is known to us independently of any events in time. What happens in time occupies time. This relation of events to the time occupied, namely this relation of occupation, is a fundamental relation of nature to time. Thus the theory requires that we are aware of two fundamental relations, the time-ordering relation between instants, and the time-occupation relation between instants of time and states of nature which happen at those instants.

There are two considerations which lend powerful support to the reigning theory of absolute time. In the first place time extends beyond nature. Our thoughts are in time. Accordingly it seems impossible to derive time merely from relations between elements of nature. For in that case temporal relations could not relate thoughts. Thus, to use a metaphor, time would apparently have deeper roots in reality than has nature. For we can imagine thoughts related in time without any perception of nature. For example we can imagine one of Milton's angels with thoughts succeeding each other in time, who does not happen to have noticed that the Almighty has created space and set therein a material universe. As a matter of fact I think that Milton set space on the same absolute level as time. But that need not disturb the illustration. In the second place it is difficult to derive the true serial character of time from the relative theory. Each instant is irrevocable. It can never recur by the very character of time. But if on the relative theory an instant of time is simply the state of nature at that time, and the time-ordering relation is simply the relation between such states, then the irrevocableness of time would seem to mean that an actual state of all nature can never return. I admit it seems unlikely that there should ever be such a recurrence down to the smallest particular. But extreme unlikeliness is not the point. Our ignorance is so abysmal that our judgments of likeliness and unlikeliness of future events hardly count. The real point is that the exact recurrence of a state of nature seems merely unlikely, while the recurrence of an instant of time violates our whole concept of time-order. The instants of time which have passed, are passed, and can never be again.

Any alternative theory of time must reckon with these two con-

siderations which are buttresses of the absolute theory. But I will not now continue their discussion.

The absolute theory of space is analogous to the corresponding theory of time, but the reasons for its maintenance are weaker. Space, on this theory, is a system of extensionless points which are the relata in space-ordering relations which can technically be combined into one relation. This relation does not arrange the points in one linear series analogously to the simple method of the time-ordering relation for instants. The essential logical characteristics of this relation from which all the properties of space spring are expressed by mathematicians in the axioms of geometry. From these axioms * as framed by modern mathematicians the whole science of geometry can be deduced by the strictest logical reasoning. The details of these axioms do not now concern us. The points and the relations are jointly known to us in our apprehension of space, each implying the other. What happens in space, occupies space. This relation of occupation is not usually stated for events but for objects. For example, Pompey's statue would be said to occupy space, but not the event which was the assassination of Julius Caesar. In this I think that ordinary usage is unfortunate, and I hold that the relations of events to space and to time are in all respects analogous. But here I am intruding my own opinions which are to be discussed in subsequent lectures. Thus the theory of absolute space requires that we are aware of two fundamental relations, the space-ordering relation, which holds between points, and the space-occupation relation between points of space and material objects.

This theory lacks the two main supports of the corresponding theory of absolute time. In the first place space does not extend beyond nature in the sense that time seems to do. Our thoughts do not seem to occupy space in quite the same intimate way in which they occupy time. For example, I have been thinking in a room, and to that extent my thoughts are in space. But it seems nonsense to ask how much volume of the room they occupied, whether it was a cubic foot or a cubic inch; whereas the same thoughts occupy a determinate duration of time, say, from eleven to twelve on a certain date.

Thus whereas the relations of a relative theory of time are required

* Cf. (for example) *Projective Geometry*, by Veblen and Young, vol. i, 1910, vol. ii, 1917 (Ginn and Company, Boston).

to relate thoughts, it does not seem so obvious that the relations of a relative theory of space are required to relate them. The connexion of thought with space seems to have a certain character of indirectness which appears to be lacking in the connexion of thought with time.

Again the irrevocableness of time does not seem to have any parallel for space. Space, on the relative theory, is the outcome of certain relations between objects commonly said to be in space; and whenever there are the objects, so related, there is the space. No difficulty seems to arise like that of the inconvenient instants of time which might conceivably turn up again when we thought that we had done with them.

The absolute theory of space is not now generally popular. The knowledge of bare space, as a system of entities known to us in itself and for itself independently of our knowledge of the events in nature, does not seem to correspond to anything in our experience. Space, like time, would appear to be an abstraction from events. According to my own theory it only differentiates itself from time at a somewhat developed stage of the abstractive process. The more usual way of expressing the relational theory of space would be to consider space as an abstraction from the relations between material objects.

Suppose now we assume absolute time and absolute space. What bearing has this assumption on the concept of nature as bifurcated into causal nature and apparent nature? Undoubtedly the separation between the two natures is now greatly mitigated. We can provide them with two systems of relations in common; for both natures can be presumed to occupy the same space and the same time. The theory now is this: Causal events occupy certain periods of the absolute time and occupy certain positions of the absolute space. These events influence a mind which thereupon perceives certain apparent events which occupy certain periods in the absolute time and occupy certain positions of the absolute space; and the periods and positions occupied by the apparent events bear a determinate relation to the periods and positions occupied by the causal events.

Furthermore definite causal events produce for the mind definite apparent events. Delusions are apparent events which appear in temporal periods and spatial positions without the intervention of

these causal events which are proper for influencing of the mind to their perception.

The whole theory is perfectly logical. In these discussions we cannot hope to drive an unsound theory to a logical contradiction. A reasoner, apart from mere slips, only involves himself in a contradiction when he is shying at a *reductio ad absurdum*. The substantial reason for rejecting a philosophical theory is the 'absurdum' to which it reduces us. In the case of the philosophy of natural science the 'absurdum' can only be that our perceptual knowledge has not the character assigned to it by the theory. If our opponent affirms that his knowledge has that character, we can only—after making doubly sure that we understand each other—agree to differ. Accordingly the first duty of an expositor in stating a theory in which he disbelieves is to exhibit it as logical. It is not there where his trouble lies.

Let me summarise the previously stated objections to this theory of nature. In the first place it seeks for the cause of the knowledge of the thing known instead of seeking for the character of the thing known: secondly it assumes a knowledge of time in itself apart from events related in time: thirdly it assumes a knowledge of space in itself apart from events related in space. There are in addition to these objections other flaws in the theory.

Some light is thrown on the artificial status of causal nature in this theory by asking, why causal nature is presumed to occupy time and space. This really raises the fundamental question as to what characteristics causal nature should have in common with apparent nature. Why—on this theory—should the cause which influences the mind to perception have any characteristics in common with the effluent apparent nature? In particular, why should it be in space? Why should it be in time? And more generally, What do we know about mind which would allow us to infer any particular characteristics of a cause which should influence mind to particular effects?

The transcendence of time beyond nature gives some slight reason for presuming that causal nature should occupy time. For if the mind occupies periods of time, there would seem to be some vague reason for assuming that influencing causes occupy the same periods of time, or at least, occupy periods which are strictly related to the mental periods. But if the mind does not occupy volumes of space,

there seems to be no reason why causal nature should occupy any volumes of space. Thus space would seem to be merely apparent in the same sense as apparent nature is merely apparent. Accordingly if science is really investigating causes which operate on the mind, it would seem to be entirely on the wrong track in presuming that the causes which it is seeking for have spatial relations. Furthermore there is nothing else in our knowledge analogous to these causes which influence the mind to perception. Accordingly, beyond the rashly presumed fact that they occupy time, there is really no ground by which we can determine any point of their character. They must remain for ever unknown.

Now I assume as an axiom that science is not a fairy tale. It is not engaged in decking out unknowable entities with arbitrary and fantastic properties. What then is it that science is doing, granting that it is effecting something of importance? My answer is that it is determining the character of things known, namely the character of apparent nature. But we may drop the term 'apparent'; for there is but one nature, namely the nature which is before us in perceptual knowledge. The characters which science discerns in nature are subtle characters, not obvious at first sight. They are relations of relations and characters of characters. But for all their subtlety they are stamped with a certain simplicity which makes their consideration essential in unravelling the complex relations between characters of more perceptive insistence.

The fact that the bifurcation of nature into causal and apparent components does not express what we mean by our knowledge is brought before us when we realise our thoughts in any discussion of the causes of our perceptions. For example, the fire is burning and we see a red coal. This is explained in science by radiant energy from the coal entering our eyes. But in seeking for such an explanation we are not asking what are the sort of occurrences which are fitted to cause a mind to see red. The chain of causation is entirely different. The mind is cut out altogether. The real question is, When red is found in nature, what else is found there also? Namely we are asking for an analysis of the accompaniments in nature of the discovery of red in nature. In a subsequent lecture I shall expand this line of thought. I simply draw attention to it here in order to point out that the wave-theory of light has not been adopted because waves are just the sort of things which ought to make a mind perceive

colours. This is no part of the evidence which has ever been adduced for the wave-theory, yet on the causal theory of perception, it is really the only relevant part. In other words, science is not discussing the causes of knowledge, but the coherence of knowledge. The understanding which is sought by science is an understanding of relations within nature.

So far I have discussed the bifurcation of nature in connexion with the theories of absolute time and of absolute space. My reason has been that the introduction of the relational theories only weakens the case for bifurcation, and I wished to discuss this case on its strongest grounds.

For instance, suppose we adopt the relational theory of space. Then the space in which apparent nature is set is the expression of certain relations between the apparent objects. It is a set of apparent relations between apparent relata. Apparent nature is the dream, and the apparent relations of space are dream relations, and the space is the dream space. Similarly the space in which causal nature is set is the expression of certain relations between the causal objects. It is the expression of certain facts about the causal activity which is going on behind the scenes. Accordingly causal space belongs to a different order of reality to apparent space. Hence there is no point-wise connexion between the two and it is meaningless to say that the molecules of the grass are in any place which has a determinate spatial relation to the place occupied by the grass which we see. This conclusion is very paradoxical and makes nonsense of all scientific phraseology. The case is even worse if we admit the relativity of time. For the same arguments apply, and break up time into the dream time and causal time which belong to different orders of reality.

I have however been discussing an extreme form of the bifurcation theory. It is, as I think, the most defensible form. But its very definiteness makes it the more evidently obnoxious to criticism. The intermediate form allows that the nature we are discussing is always the nature directly known, and so far it rejects the bifurcation theory. But it holds that there are psychic additions to nature as thus known, and that these additions are in no proper sense part of nature. For example, we perceive the red billiard ball at its proper time, in its proper place, with its proper motion, with its proper hardness, and with its proper inertia. But its redness and its warmth, and the

sound of the click as a cannon is made off it are psychic additions, namely, secondary qualities which are only the mind's way of perceiving nature. This is not only the vaguely prevalent theory, but is, I believe, the historical form of the bifurcation theory in so far as it is derived from philosophy. I shall call it the theory of psychic additions.

This theory of psychic additions is a sound common-sense theory which lays immense stress on the obvious reality of time, space, solidity and inertia, but distrusts the minor artistic additions of colour, warmth and sound.

The theory is the outcome of common sense in retreat. It arose in an epoch when the transmission theories of science were being elaborated. For example, colour is the result of a transmission from the material object to the perceiver's eye; and what is thus transmitted is not colour. Thus colour is not part of the reality of the material object. Similarly for the same reason sounds evaporate from nature. Also warmth is due to the transfer of something which is not temperature. Thus we are left with spatio-temporal positions, and what I may term the 'pushiness' of the body. This leads us to eighteenth and nineteenth century materialism, namely, the belief that what is real in nature is matter, in time and in space and with inertia.

Evidently a distinction in quality has been presupposed separating off some perceptions due to touch from other perceptions. These touch-perceptions are perceptions of the real inertia, whereas the other perceptions are psychic additions which must be explained on the causal theory. This distinction is the product of an epoch in which physical science has got ahead of medical pathology and of physiology. Perceptions of push are just as much the outcome of transmission as are perceptions of colour. When colour is perceived the nerves of the body are excited in one way and transmit their message towards the brain, and when push is perceived other nerves of the body are excited in another way and transmit their message towards the brain. The message of the one set is not the conveyance of colour, and the message of the other set is not the conveyance of push. But in one case colour is perceived and in the other case the push due to the object. If you snip certain nerves, there is an end to the perception of colour; and if you snip certain other nerves, there is an end to the perception of push. It would appear therefore

that any reasons which should remove colour from the reality of nature should also operate to remove inertia.

Thus the attempted bifurcation of apparent nature into two parts of which one part is both causal for its own appearance and for the appearance of the other part, which is purely apparent, fails owing to the failure to establish any fundamental distinction between our ways of knowing about the two parts of nature as thus partitioned. I am not denying that the feeling of muscular effort historically led to the formulation of the concept of force. But this historical fact does not warrant us in assigning a superior reality in nature to material inertia over colour or sound. So far as reality is concerned all our sense-perceptions are in the same boat, and must be treated on the same principle. The evenness of treatment is exactly what this compromise theory fails to achieve.

The bifurcation theory however dies hard. The reason is that there really is a difficulty to be faced in relating within the same system of entities the redness of the fire with the agitation of the molecules. In another lecture I will give my own explanation of the origin of the difficulty and of its solution.

Another favourite solution, the most attenuated form which the bifurcation theory assumes, is to maintain that the molecules and ether of science are purely conceptual. Thus there is but one nature, namely apparent nature, and atoms and ether are merely names for logical terms in conceptual formulae of calculation.

But what is a formula of calculation? It is presumably a statement that something or other is true for natural occurrences. Take the simplest of all formulae, Two and two make four. This—so far as it applies to nature—asserts that if you take two natural entities, and then again two other natural entities, the combined class contains four natural entities. Such formulae which are true for any entities cannot result in the production of the concepts of atoms. Then again there are formulae which assert that there are entities in nature with such and such special properties, say, for example, with the properties of the atoms of hydrogen. Now if there are no such entities, I fail to see how any statements about them can apply to nature. For example, the assertion that there is green cheese in the moon cannot be a premiss in any deduction of scientific importance, unless indeed the presence of green cheese in the moon has been

verified by experiment. The current answer to these objections is that, though atoms are merely conceptual, yet they are an interesting and picturesque way of saying something else which is true of nature. But surely if it is something else that you mean, for heaven's sake say it. Do away with this elaborate machinery of a conceptual nature which consists of assertions about things which don't exist in order to convey truths about things which do exist. I am maintaining the obvious position that scientific laws, if they are true, are statements about entities which we obtain knowledge of as being in nature; and that, if the entities to which the statements refer are not to be found in nature, the statements about them have no relevance to any purely natural occurrence. Thus the molecules and electrons of scientific theory are, so far as science has correctly formulated its laws, each of them factors to be found in nature. The electrons are only hypothetical in so far as we are not quite certain that the electron theory is true. But their hypothetical character does not arise from the essential nature of the theory in itself after its truth has been granted.

Thus at the end of this somewhat complex discussion, we return to the position which was affirmed at its beginning. The primary task of a philosophy of natural science is to elucidate the concept of nature, considered as one complex fact for knowledge, to exhibit the fundamental entities and the fundamental relations between entities in terms of which all laws of nature have to be stated, and to secure that the entities and relations thus exhibited are adequate for the expression of all the relations between entities which occur in nature.

The third requisite, namely that of adequacy, is the one over which all the difficulty occurs. The ultimate data of science are commonly assumed to be time, space, material, qualities of material, and relations between material objects. But data as they occur in the scientific laws do not relate all the entities which present themselves in our perception of nature. For example, the wave-theory of light is an excellent well-established theory; but unfortunately it leaves out colour as perceived. Thus the perceived redness—or, other colour—has to be cut out of nature and made into the reaction of the mind under the impulse of the actual events of nature. In other words this concept of the fundamental relations within nature is inadequate.

Thus we have to bend our energies to the enunciation of adequate concepts.

But in so doing, are we not in fact endeavouring to solve a metaphysical problem? I do not think so. We are merely endeavouring to exhibit the type of relations which hold between the entities which we in fact perceive as in nature. We are not called on to make any pronouncement as to the psychological relation of subjects to objects or as to the status of either in the realm of reality. It is true that the issue of our endeavour may provide material which is relevant evidence for a discussion on that question. It can hardly fail to do so. But it is only evidence, and is not itself the metaphysical discussion. In order to make clear the character of this further discussion which is out of our ken, I will set before you two quotations. One is from Schelling and I extract the quotation from the work of the Russian philosopher Lossky which has recently been so excellently translated into English *—'In the "Philosophy of Nature" I considered the subject-object called nature in its activity of self-constructing. In order to understand it, we must rise to an intellectual intuition of nature. The empiricist does not rise thereto, and for this reason in all his explanations it is always *he himself* that proves to be constructing nature. It is no wonder, then, that his construction and that which was to be constructed so seldom coincide. A *Natur-philosoph* raises nature to independence, and makes it construct itself, and he never feels, therefore, the necessity of opposing nature as constructed (*i.e.* as experience) to real nature, or of correcting the one by means of the other.'

The other quotation is from a paper read by the Dean of St Paul's before the Aristotelian Society in May of 1919. Dr Inge's paper is entitled 'Platonism and Human Immortality,' and in it there occurs the following statement: 'To sum up. The Platonic doctrine of immortality rests on the *independence* of the spiritual world. The spiritual world is not a world of unrealised ideals, over against a real world of unspiritual fact. It is, on the contrary, the real world, of which we have a true though very incomplete knowledge, over against a world of common experience which, as a complete whole, is not real, since it is compacted out of miscellaneous data, not all on

* *The Intuitive Basis of Knowledge,* by N. O. Lossky, transl. by Mrs Duddington (Macmillan, 1919).

the same level, by the help of the imagination. There is no world corresponding to the world of our common experience. Nature makes abstractions for us, deciding what range of vibrations we are to see and hear, what things we are to notice and remember.'

I have cited these statements because both of them deal with topics which, though they lie outside the range of our discussion, are always being confused with it. The reason is that they lie proximate to our field of thought, and are topics which are of burning interest to the metaphysically minded. It is difficult for a philosopher to realise that anyone really is confining his discussion within the limits that I have set before you. The boundary is set up just where he is beginning to get excited. But I submit to you that among the necessary prolegomena for philosophy and for natural science is a thorough understanding of the types of entities, and types of relations among those entities, which are disclosed to us in our perceptions of nature.

CHAPTER III *TIME*

The two previous lectures of this course have been mainly critical. In the present lecture I propose to enter upon a survey of the kinds of entities which are posited for knowledge in sense-awareness. My purpose is to investigate the sorts of relations which these entities of various kinds can bear to each other. A classification of natural entities is the beginning of natural philosophy. To-day we commence with the consideration of Time.

In the first place there is posited for us a general fact: namely, something is going on; there is an occurrence for definition.

This general fact at once yields for our apprehension two factors, which I will name, the 'discerned' and the 'discernible.' The discerned is comprised of those elements of the general fact which are discriminated with their own individual peculiarities. It is the field directly perceived. But the entities of this field have relations to other entities which are not particularly discriminated in this individual way. These other entities are known merely as the relata in relation to the entities of the discerned field. Such an entity is merely a 'something'

which has such-and-such definite relations to some definite entity or entities in the discerned field. As being thus related, they are—owing to the particular character of these relations—known as elements of the general fact which is going on. But we are not aware of them except as entities fulfilling the functions of relata in these relations.

Thus the complete general fact, posited as occurring, comprises both sets of entities, namely the entities perceived in their own individuality and other entities merely apprehended as relata without further definition. This complete general fact is the discernible and it comprises the discerned. The discernible is all nature as disclosed in that sense-awareness, and extends beyond and comprises all of nature as actually discriminated or discerned in that sense-awareness. The discerning or discrimination of nature is a peculiar awareness of special factors in nature in respect to their peculiar characters. But the factors in nature of which we have this peculiar sense-awareness are known as not comprising all the factors which together form the whole complex of related entities within the general fact there for discernment. This peculiarity of knowledge is what I call its unexhaustive character. This character may be metaphorically described by the statement that nature as perceived always has a ragged edge. For example, there is a world beyond the room to which our sight is confined known to us as completing the space-relations of the entities discerned within the room. The junction of the interior world of the room with the exterior world beyond is never sharp. Sounds and subtler factors disclosed in sense-awareness float in from the outside. Every type of sense has its own set of discriminated entities which are known to be relata in relation with entities not discriminated by that sense. For example we see something which we do not touch and we touch something which we do not see, and we have a general sense of the space-relations between the entity disclosed in sight and the entity disclosed in touch. Thus in the first place each of these two entities is known as a relatum in a general system of space-relations and in the second place the particular mutual relation of these two entities as related to each other in this general system is determined. But the general system of space-relations relating the entity discriminated by sight with that discriminated by touch is not dependent on the peculiar character of the other entity as reported by the alternative sense. For example, the space-relations of the thing seen would have necessitated an entity as a relatum in the place

of the thing touched even although certain elements of its character had not been disclosed by touch. Thus apart from the touch an entity with a certain specific relation to the thing seen would have been disclosed by sense-awareness but not otherwise discriminated in respect to its individual character. An entity merely known as spatially related to some discerned entity is what we mean by the bare idea of 'place.' The concept of place marks the disclosure in sense-awareness of entities in nature known merely by their spatial relations to discerned entities. It is the disclosure of the discernible by means of its relations to the discerned.

This disclosure of an entity as a relatum without further specific discrimination of quality is the basis of our concept of significance. In the above example the thing seen was significant, in that it disclosed its spatial relations to other entities not necessarily otherwise entering into consciousness. Thus significance is relatedness, but it is relatedness with the emphasis on one end only of the relation.

For the sake of simplicity I have confined the argument to spatial relations; but the same considerations apply to temporal relations. The concept of 'period of time' marks the disclosure in sense-awareness of entities in nature known merely by their temporal relations to discerned entities. Still further, this separation of the ideas of space and time has merely been adopted for the sake of gaining simplicity of exposition by conformity to current language. What we discern is the specific character of a place through a period of time. This is what I mean by an 'event.' We discern some specific character of an event. But in discerning an event we are also aware of its significance as a relatum in the structure of events. This structure of events is the complex of events as related by the two relations of extension and cogredience. The most simple expression of the properties of this structure are to be found in our spatial and temporal relations. A discerned event is known as related in this structure to other events whose specific characters are otherwise not disclosed in that immediate awareness except so far as that they are relata within the structure.

The disclosure in sense-awareness of the structure of events classifies events into those which are discerned in respect to some further individual character and those which are not otherwise disclosed except as elements of the structure. These signified events must include events in the remote past as well as events in the future. We are

aware of these as the far off periods of unbounded time. But there is another classification of events which is also inherent in sense-awareness. These are the events which share the immediacy of the immediately present discerned events. These are the events whose characters together with those of the discerned events comprise all nature present for discernment. They form the complete general fact which is all nature now present as disclosed in that sense-awareness. It is in this second classification of events that the differentiation of space from time takes its origin. The germ of space is to be found in the mutual relations of events within the immediate general fact which is all nature now discernible, namely within the one event which is the totality of present nature. The relations of other events to this totality of nature form the texture of time.

The unity of this general present fact is expressed by the concept of simultaneity. The general fact is the whole simultaneous occurrence of nature which is now for sense-awareness. This general fact is what I have called the discernible. But in future I will call it a 'duration,' meaning thereby a certain whole of nature which is limited only by the property of being a simultaneity. Further in obedience to the principle of comprising within nature the whole terminus of sense-awareness, simultaneity must not be conceived as an irrelevant mental concept imposed upon nature. Our sense-awareness posits for immediate discernment a certain whole, here called a 'duration'; thus a duration is a definite natural entity. A duration is discriminated as a complex of partial events, and the natural entities which are components of this complex are thereby said to be 'simultaneous with this duration.' Also in a derivative sense they are simultaneous with each other in respect to this duration. Thus simultaneity is a definite natural relation. The word 'duration' is perhaps unfortunate in so far as it suggests a mere abstract stretch of time. This is not what I mean. A duration is a concrete slab of nature limited by simultaneity which is an essential factor disclosed in sense-awareness.

Nature is a process. As in the case of everything directly exhibited in sense-awareness, there can be no explanation of this characteristic of nature. All that can be done is to use language which may speculatively demonstrate it, and also to express the relation of this factor in nature to other factors.

It is an exhibition of the process of nature that each duration

happens and passes. The process of nature can also be termed the passage of nature. I definitely refrain at this stage from using the word 'time,' since the measurable time of science and of civilised life generally merely exhibits some aspects of the more fundamental fact of the passage of nature. I believe that in this doctrine I am in full accord with Bergson, though he uses 'time' for the fundamental fact which I call the 'passage of nature.' Also the passage of nature is exhibited equally in spatial transition as well as in temporal transition. It is in virtue of its passage that nature is always moving on. It is involved in the meaning of this property of 'moving on' that not only is any act of sense-awareness just that act and no other, but the terminus of each act is also unique and is the terminus of no other act. Sense-awareness seizes its only chance and presents for knowledge something which is for it alone.

There are two senses in which the terminus of sense-awareness is unique. It is unique for the sense-awareness of an individual mind and it is unique for the sense-awareness of all minds which are operating under natural conditions. There is an important distinction between the two cases. (i) For one mind not only is the discerned component of the general fact exhibited in any act of sense-awareness distinct from the discerned component of the general fact exhibited in any other act of sense-awareness of that mind, but the two corresponding durations which are respectively related by simultaneity to the two discerned components are necessarily distinct. This is an exhibition of the temporal passage of nature; namely, one duration has passed into the other. Thus not only is the passage of nature an essential character of nature in its *rôle* of the terminus of sense-awareness, but it is also essential for sense-awareness in itself. It is this truth which makes time appear to extend beyond nature. But what extends beyond nature to mind is not the serial and measurable time, which exhibits merely the character of passage in nature, but the quality of passage itself which is in no way measurable except so far as it obtains in nature. That is to say, 'passage' is not measurable except as it occurs in nature in connexion with extension. In passage we reach a connexion of nature with the ultimate metaphysical reality. The quality of passage in durations is a particular exhibition in nature of a quality which extends beyond nature. For example passage is a quality not only of nature, which is the thing known, but also of sense-awareness which is the procedure of knowing. Dura-

tions have all the reality that nature has, though what that may be we need not now determine. The measurableness of time is derivative from the properties of durations. So also is the serial character of time. We shall find that there are in nature competing serial time-systems derived from different families of durations. These are a peculiarity of the character of passage as it is found in nature. This character has the reality of nature, but we must not necessarily transfer natural time to extra-natural entities. (ii) For two minds, the discerned components of the general facts exhibited in their respective acts of sense-awareness must be different. For each mind, in its awareness of nature is aware of a certain complex of related natural entities in their relations to the living body as a focus. But the associated durations may be identical. Here we are touching on that character of the passage of nature which issues in the spatial relations of simultaneous bodies. This possible identity of the durations in the case of the sense-awareness of distinct minds is what binds into one nature the private experiences of sentient beings. We are here considering the spatial side of the passage of nature. Passage in this aspect of it also seems to extend beyond nature to mind.

It is important to distinguish simultaneity from instantaneousness. I lay no stress on the mere current usage of the two terms. There are two concepts which I want to distinguish, and one I call simultaneity and the other instantaneousness. I hope that the words are judiciously chosen; but it really does not matter so long as I succeed in explaining my meaning. Simultaneity is the property of a group of natural elements which in some sense are components of a duration. A duration can be all nature present as the immediate fact posited by sense-awareness. A duration retains within itself the passage of nature. There are within it antecedents and consequents which are also durations which may be the complete specious presents of quicker consciousnesses. In other words a duration retains temporal thickness. Any concept of all nature as immediately known is always a concept of some duration though it may be enlarged in its temporal thickness beyond the possible specious present of any being known to us as existing within nature. Thus simultaneity is an ultimate factor in nature, immediate for sense-awareness.

Instantaneousness is a complex logical concept of a procedure in thought by which constructed logical entities are produced for the sake of the simple expression in thought of properties of nature. In-

stantaneousness is the concept of all nature at an instant, where an instant is conceived as deprived of all temporal extension. For example we conceive of the distribution of matter in space at an instant. This is a very useful concept in science especially in applied mathematics; but it is a very complex idea so far as concerns its connexions with the immediate facts of sense-awareness. There is no such thing as nature at an instant posited by sense-awareness. What sense-awareness delivers over for knowledge is nature through a period. Accordingly nature at an instant, since it is not itself a natural entity, must be defined in terms of genuine natural entities. Unless we do so, our science, which employs the concept of instantaneous nature, must abandon all claim to be founded upon observation.

I will use the term 'moment' to mean 'all nature at an instant.' A moment, in the sense in which the term is here used, has no temporal extension, and is in this respect to be contrasted with a duration which has such extension. What is directly yielded to our knowledge by sense-awareness is a duration. Accordingly we have now to explain how moments are derived from durations, and also to explain the purpose served by their introduction.

A moment is a limit to which we approach as we confine attention to durations of minimum extension. Natural relations among the ingredients of a duration gain in complexity as we consider durations of increasing temporal extension. Accordingly there is an approach to ideal simplicity as we approach an ideal diminution of extension.

The word 'limit' has a precise signification in the logic of number and even in the logic of non-numerical one-dimensional series. As used here it is so far a mere metaphor, and it is necessary to explain directly the concept which it is meant to indicate.

Durations can have the two-termed relational property of extending one over the other. Thus the duration which is all nature during a certain minute extends over the duration which is all nature during the 30th second of that minute. This relation of 'extending over' —'extension' as I shall call it—is a fundamental natural relation whose field comprises more than durations. It is a relation which two limited events can have to each other. Furthermore as holding between durations the relation appears to refer to the purely temporal extension. I shall however maintain that the same relation of extension lies at the base both of temporal and spatial extension. This

discussion can be postponed; and for the present we are simply concerned with the relation of extension as it occurs in its temporal aspect for the limited field of durations.

The concept of extension exhibits in thought one side of the ultimate passage of nature. This relation holds because of the special character which passage assumes in nature; it is the relation which in the case of durations expresses the properties of 'passing over.' Thus the duration which was one definite minute passed over the duration which was its 30th second. The duration of the 30th second was part of the duration of the minute. I shall use the terms 'whole' and 'part' exclusively in this sense, that the 'part' is an event which is extended over by the other event which is the 'whole.' Thus in my nomenclature 'whole' and 'part' refer exclusively to this fundamental relation of extension; and accordingly in this technical usage only events can be either wholes or parts.

The continuity of nature arises from extension. Every event extends over other events, and every event is extended over by other events. Thus in the special case of durations which are now the only events directly under consideration, every duration is part of other durations; and every duration has other durations which are parts of it. Accordingly there are no maximum durations and no minimum durations. Thus there is no atomic structure of durations, and the perfect definition of a duration, so as to mark out its individuality and distinguish it from highly analogous durations over which it is passing, or which are passing over it, is an arbitrary postulate of thought. Sense-awareness posits durations as factors in nature but does not clearly enable thought to use it as distinguishing the separate individualities of the entities of an allied group of slightly differing durations. This is one instance of the indeterminateness of sense-awareness. Exactness is an ideal of thought, and is only realised in experience by the selection of a route of approximation.

The absence of maximum and minimum durations does not exhaust the properties of nature which make up its continuity. The passage of nature involves the existence of a family of durations. When two durations belong to the same family either one contains the other, or they overlap each other in a subordinate duration without either containing the other; or they are completely separate. The excluded case is that of durations overlapping in finite events but not containing a third duration as a common part.

It is evident that the relation of extension is transitive; namely as applied to durations, if duration *A* is part of duration *B*, and duration *B* is part of duration *C*, then *A* is part of *C*. Thus the first two cases may be combined into one and we can say that two durations which belong to the same family *either* are such that there are durations which are parts of both *or* are completely separate.

Furthermore the converse of this proposition holds; namely, if two durations have other durations which are parts of both *or* if the two durations are completely separate, then they belong to the same family.

The further characteristics of the continuity of nature—so far as durations are concerned—which has not yet been formulated arises in connexion with a family of durations. It can be stated in this way: There are durations which contain as parts any two durations of the same family. For example a week contains as parts any two of its days. It is evident that a containing duration satisfies the conditions for belonging to the same family as the two contained durations.

We are now prepared to proceed to the definition of a moment of time. Consider a set of durations all taken from the same family. Let it have the following properties: (i) of any two members of the set one contains the other as a part, and (ii) there is no duration which is a common part of every member of the set.

Now the relation of whole and part is asymmetrical; and by this I mean that if *A* is part of *B*, then *B* is not part of *A*. Also we have already noted that the relation is transitive. Accordingly we can easily see that the durations of any set with the properties just enumerated must be arranged in a one-dimensional serial order in which as we descend the series we progressively reach durations of smaller and smaller temporal extension. The series may start with any arbitrarily assumed duration of any temporal extension, but in descending the series the temporal extension progressively contracts and the successive durations are packed one within the other like the nest of boxes of a Chinese toy. But the set differs from the toy in this particular: the toy has a smallest box which forms the end box of its series; but the set of durations can have no smallest duration nor can it converge towards a duration as its limit. For the parts either of the end duration or of the limit would be parts of all the durations of the set and thus the second condition for the set would be violated.

I will call such a set of durations an 'abstractive set' of durations. It is evident that an abstractive set as we pass along it converges to the ideal of all nature with no temporal extension, namely, to the ideal of all nature at an instant. But this ideal is in fact the ideal of a nonentity. What the abstractive set is in fact doing is to guide thought to the consideration of the progressive simplicity of natural relations as we progressively diminish the temporal extension of the duration considered. Now the whole point of the procedure is that the quantitative expressions of these natural properties do converge to limits though the abstractive set does not converge to any limiting duration. The laws relating these quantitative limits are the laws of nature 'at an instant,' although in truth there is no nature at an instant and there is only the abstractive set. Thus an abstractive set is effectively the entity meant when we consider an instant of time without temporal extension. It subserves all the necessary purposes of giving a definite meaning to the concept of the properties of nature at an instant. I fully agree that this concept is fundamental in the expression of physical science. The difficulty is to express our meaning in terms of the immediate deliverances of sense-awareness, and I offer the above explanation as a complete solution of the problem.

In this explanation a moment is the set of natural properties reached by a route of approximation. An abstractive series is a route of approximation. There are different routes of approximation to the same limiting set of the properties of nature. In other words there are different abstractive sets which are to be regarded as routes of approximation to the same moment. Accordingly there is a certain amount of technical detail necessary in explaining the relations of such abstractive sets with the same convergence and in guarding against possible exceptional cases. Such details are not suitable for exposition in these lectures, and I have dealt with them fully elsewhere.*

It is more convenient for technical purposes to look on a moment as being the class of all abstractive sets of durations with the same convergence. With this definition (provided that we can successfully explain what we mean by the 'same convergence' apart from a detailed knowledge of the set of natural properties arrived at by approximation) a moment is merely a class of sets of durations whose

* Cf. *An Enquiry Concerning the Principles of Natural Knowledge* (Cambridge University Press, 1919).

relations of extension in respect to each other have certain definite peculiarities. We may term these connexions of the component durations the 'extrinsic' properties of a moment; the 'intrinsic' properties of the moment are the properties of nature arrived at as a limit as we proceed along any one of its abstractive sets. These are the properties of nature 'at that moment,' or 'at that instant.'

The durations which enter into the composition of a moment all belong to one family. Thus there is one family of moments corresponding to one family of durations. Also if we take two moments of the same family, among the durations which enter into the composition of one moment the smaller durations are completely separated from the smaller durations which enter into the composition of the other moment. Thus the two moments in their intrinsic properties must exhibit the limits of completely different states of nature. In this sense the two moments are completely separated. I will call two moments of the same family 'parallel.'

Corresponding to each duration there are two moments of the associated family of moments which are the boundary moments of that duration. A 'boundary moment' of a duration can be defined in this way. There are durations of the same family as the given duration which overlap it but are not contained in it. Consider an abstractive set of such durations. Such a set defines a moment which is just as much without the duration as within it. Such a moment is a boundary moment of the duration. Also we call upon our sense-awareness of the passage of nature to inform us that there are two such boundary moments, namely the earlier one and the later one. We will call them the initial and the final boundaries.

There are also moments of the same family such that the shorter durations in their composition are entirely separated from the given duration. Such moments will be said to lie 'outside' the given duration. Again other moments of the family are such that the shorter durations in their composition are parts of the given duration. Such moments are said to lie 'within' the given duration or to 'inhere' in it. The whole family of parallel moments is accounted for in this way by reference to any given duration of the associated family of durations. Namely, there are moments of the family which lie without the given duration, there are the two moments which are the boundary moments of the given duration, and the moments which lie within the given duration. Furthermore any two moments of the

same family are the boundary moments of some one duration of the associated family of durations.

It is now possible to define the serial relation of temporal order among the moments of a family. For let A and C be any two moments of the family, these moments are the boundary moments of one duration d of the associated family, and any moment B which lies within the duration d will be said to lie between the moments A and C. Thus the three-termed relation of 'lying-between' as relating three moments A, B, and C is completely defined. Also our knowledge of the passage of nature assures us that this relation distributes the moments of the family into a serial order. I abstain from enumerating the definite properties which secure this result, I have enumerated them in my recently published book * to which I have already referred. Furthermore the passage of nature enables us to know that one direction along the series corresponds to passage into the future and the other direction corresponds to retrogression towards the past.

Such an ordered series of moments is what we mean by time defined as a series. Each element of the series exhibits an instantaneous state of nature. Evidently this serial time is the result of an intellectual process of abstraction. What I have done is to give precise definitions of the procedure by which the abstraction is effected. This procedure is merely a particular case of the general method which in my book I name the 'method of extensive abstraction.' This serial time is evidently not the very passage of nature itself. It exhibits some of the natural properties which flow from it. The state of nature 'at a moment' has evidently lost this ultimate quality of passage. Also the temporal series of moments only retains it as an extrinsic relation of entities and not as the outcome of the essential being of the terms of the series.

Nothing has yet been said as to the measurement of time. Such measurement does not follow from the mere serial property of time; it requires a theory of congruence which will be considered in a later lecture.

In estimating the adequacy of this definition of the temporal series as a formulation of experience it is necessary to discriminate between the crude deliverance of sense-awareness and our intellectual theories. The lapse of time is a measurable serial quantity. The

* Cf. *Enquiry*.

whole of scientific theory depends on this assumption and any theory of time which fails to provide such a measurable series stands self-condemned as unable to account for the most salient fact in experience. Our difficulties only begin when we ask what it is that is measured. It is evidently something so fundamental in experience that we can hardly stand back from it and hold it apart so as to view it in its own proportions.

We have first to make up our minds whether time is to be found in nature or nature is to be found in time. The difficulty of the latter alternative—namely of making time prior to nature—is that time then becomes a metaphysical enigma. What sort of entities are its instants or its periods? The dissociation of time from events discloses to our immediate inspection that the attempt to set up time as an independent terminus for knowledge is like the effort to find substance in a shadow. There is time because there are happenings, and apart from happenings there is nothing.

It is necessary however to make a distinction. In some sense time extends beyond nature. It is not true that a timeless sense-awareness and a timeless thought combine to contemplate a timeful nature. Sense-awareness and thought are themselves processes as well as their termini in nature. In other words there is a passage of sense-awareness and a passage of thought. Thus the reign of the quality of passage extends beyond nature. But now the distinction arises between passage which is fundamental and the temporal series which is a logical abstraction representing some of the properties of nature. A temporal series, as we have defined it, represents merely certain properties of a family of durations—properties indeed which durations only possess because of their partaking of the character of passage, but on the other hand properties which only durations do possess. Accordingly time in the sense of a measurable temporal series is a character of nature only, and does not extend to the processes of thought and of sense-awareness except by a correlation of these processes with the temporal series implicated in their procedures.

So far the passage of nature has been considered in connexion with the passage of durations; and in this connexion it is peculiarly associated with temporal series. We must remember however that the character of passage is peculiarly associated with the extension of events, and that from this extension spatial transition arises just

as much as temporal transition. The discussion of this point is reserved for a later lecture but it is necessary to remember it now that we are proceeding to discuss the application of the concept of passage beyond nature, otherwise we shall have too narrow an idea of the essence of passage.

It is necessary to dwell on the subject of sense-awareness in this connexion as an example of the way in which time concerns mind, although measurable time is a mere abstract from nature and nature is closed to mind.

Consider sense-awareness—not its terminus which is nature, but sense-awareness in itself as a procedure of mind. Sense-awareness is a relation of mind to nature. Accordingly we are now considering mind as a relatum in sense-awareness. For mind there is the immediate sense-awareness and there is memory. The distinction between memory and the present immediacy has a double bearing. On the one hand it discloses that mind is not impartially aware of all those natural durations to which it is related by awareness. Its awareness shares in the passage of nature. We can imagine a being whose awareness, conceived as his private possession, suffers no transition, although the terminus of his awareness is our own transient nature. There is no essential reason why memory should not be raised to the vividness of the present fact; and then from the side of mind, What is the difference between the present and the past? Yet with this hypothesis we can also suppose that the vivid remembrance and the present fact are posited in awareness as in their temporal serial order. Accordingly we must admit that though we can imagine that mind in the operation of sense-awareness might be free from any character of passage, yet in point of fact our experience of sense-awareness exhibits our minds as partaking in this character.

On the other hand the mere fact of memory is an escape from transience. In memory the past is present. It is not present as overleaping the temporal succession of nature, but it is present as an immediate fact for the mind. Accordingly memory is a disengagement of the mind from the mere passage of nature; for what has passed for nature has not passed for mind.

Furthermore the distinction between memory and the immediate present is not so clear as it is conventional to suppose. There is an intellectual theory of time as a moving knife-edge, exhibiting a present fact without temporal extension. This theory arises from the

concept of an ideal exactitude of observation. Astronomical observations are successively refined to be exact to tenths, to hundredths, and to thousandths of seconds. But the final refinements are arrived at by a system of averaging, and even then present us with a stretch of time as a margin of error. Here error is merely a conventional term to express the fact that the character of experience does not accord with the ideal of thought. I have already explained how the concept of a moment conciliates the observed fact with this ideal; namely, there is a limiting simplicity in the quantitative expression of the properties of durations, which is arrived at by considering any one of the abstractive sets included in the moment. In other words the extrinsic character of the moment as an aggregate of durations has associated with it the intrinsic character of the moment which is the limiting expression of natural properties.

Thus the character of a moment and the ideal of exactness which it enshrines do not in any way weaken the position that the ultimate terminus of awareness is a duration with temporal thickness. This immediate duration is not clearly marked out for our apprehension. Its earlier boundary is blurred by a fading into memory, and its later boundary is blurred by an emergence from anticipation. There is no sharp distinction either between memory and the present immediacy or between the present immediacy and anticipation. The present is a wavering breadth of boundary between the two extremes. Thus our own sense-awareness with its extended present has some of the character of the sense-awareness of the imaginary being whose mind was free from passage and who contemplated all nature as an immediate fact. Our own present has its antecedents and its consequents, and for the imaginary being all nature has its antecedent and its consequent durations. Thus the only difference in this respect between us and the imaginary being is that for him all nature shares in the immediacy of our present duration.

The conclusion of this discussion is that so far as sense-awareness is concerned there is a passage of mind which is distinguishable from the passage of nature though closely allied with it. We may speculate, if we like, that this alliance of the passage of mind with the passage of nature arises from their both sharing in some ultimate character of passage which dominates all being. But this is a speculation in which we have no concern. The immediate deduction which is sufficient for us is that—so far as sense-awareness is concerned—mind is not in

time or in space in the same sense in which the events of nature are in time, but that it is derivatively in time and in space by reason of the peculiar alliance of its passage with the passage of nature. Thus mind is in time and in space in a sense peculiar to itself. This has been a long discussion to arrive at a very simple and obvious conclusion. We all feel that in some sense our minds are here in this room and at this time. But it is not quite in the same sense as that in which the events of nature which are the existences of our brains have their spatial and temporal positions. The fundamental distinction to remember is that immediacy for sense-awareness is not the same as instantaneousness for nature. This last conclusion bears on the next discussion with which I will terminate this lecture. This question can be formulated thus, Can alternative temporal series be found in nature?

A few years ago such a suggestion would have been put aside as being fantastically impossible. It would have had no bearing on the science then current, and was akin to no ideas which had ever entered into the dreams of philosophy. The eighteenth and nineteenth centuries accepted as their natural philosophy a certain circle of concepts which were as rigid and definite as those of the philosophy of the middle ages, and were accepted with as little critical research. I will call this natural philosophy 'materialism.' Not only were men of science materialists, but also adherents of all schools of philosophy. The idealists only differed from the philosophic materialists on the question of the alignment of nature in reference to mind. But no one had any doubt that the philosophy of nature considered in itself was of the type which I have called materialism. It is the philosophy which I have already examined in my two lectures of this course preceding the present one. It can be summarised as the belief that nature is an aggregate of material and that this material exists in some sense *at* each successive member of a one-dimensional series of extensionless instants of time. Furthermore the mutual relations of the material entities at each instant formed these entities into a spatial configuration in an unbounded space. It would seem that space—on this theory—would be as instantaneous as the instants, and that some explanation is required of the relations between the successive instantaneous spaces. The materialistic theory is however silent on this point; and the succession of instantaneous spaces is tacitly combined into one persistent space. This theory is a purely

intellectual rendering of experience which has had the luck to get itself formulated at the dawn of scientific thought. It has dominated the language and the imagination of science since science flourished in Alexandria, with the result that it is now hardly possible to speak without appearing to assume its immediate obviousness.

But when it is distinctly formulated in the abstract terms in which I have just stated it, the theory is very far from obvious. The passing complex of factors which compose the fact which is the terminus of sense-awareness places before us nothing corresponding to the trinity of this natural materialism. This trinity is composed (i) of the temporal series of extensionless instants, (ii) of the aggregate of material entities, and (iii) of space which is the outcome of relations of matter.

There is a wide gap between these presuppositions of the intellectual theory of materialism and the immediate deliverances of sense-awareness. I do not question that this materialistic trinity embodies important characters of nature. But it is necessary to express these characters in terms of the facts of experience. This is exactly what in this lecture I have been endeavouring to do so far as time is concerned; and we have now come up against the question, Is there only one temporal series? The uniqueness of the temporal series is presupposed in the materialist philosophy of nature. But that philosophy is merely a theory, like the Aristotelian scientific theories so firmly believed in the Middle Ages. If in this lecture I have in any way succeeded in getting behind the theory to the immediate facts, the answer is not nearly so certain. The question can be transformed into this alternative form, Is there only one family of durations? In this question the meaning of a 'family of durations' has been defined earlier in this lecture. The answer is now not at all obvious. On the materialistic theory the instantaneous present is the only field for the creative activity of nature. The past is gone and the future is not yet. Thus (on this theory) the immediacy of perception is of an instantaneous present, and this unique present is the outcome of the past and the promise of the future. But we deny this immediately given instantaneous present. There is no such thing to be found in nature. As an ultimate fact it is a nonentity. What is immediate for sense-awareness is a duration. Now a duration has within itself a past and a future; and the temporal breadths of the immediate durations of sense-awareness are very indeterminate and dependent on the individual percipient. Accordingly there is no unique factor in

nature which for every percipient is preeminently and necessarily the present. The passage of nature leaves nothing between the past and the future. What we perceive as present is the vivid fringe of memory tinged with anticipation. This vividness lights up the discriminated field within a duration. But no assurance can thereby be given that the happenings of nature cannot be assorted into other durations of alternative families. We cannot even know that the series of immediate durations posited by the sense-awareness of one individual mind all necessarily belong to the same family of durations. There is not the slightest reason to believe that this is so. Indeed if my theory of nature be correct, it will not be the case.

The materialistic theory has all the completeness of the thought of the Middle Ages, which had a complete answer to everything, be it in heaven or in hell or in nature. There is a trimness about it, with its instantaneous present, its vanished past, its non-existent future, and its inert matter. This trimness is very medieval and ill accords with brute fact.

The theory which I am urging admits a greater ultimate mystery and a deeper ignorance. The past and the future meet and mingle in the ill-defined present. The passage of nature which is only another name for the creative force of existence has no narrow ledge of definite instantaneous present within which to operate. Its operative presence which is now urging nature forward must be sought for throughout the whole, in the remotest past as well as in the narrowest breadth of any present duration. Perhaps also in the unrealised future. Perhaps also in the future which might be as well as the actual future which will be. It is impossible to meditate on time and the mystery of the creative passage of nature without an overwhelming emotion at the limitations of human intelligence.

CHAPTER IV *THE METHOD OF EXTENSIVE ABSTRACTION*

To-day's lecture must commence with the consideration of limited events. We shall then be in a position to enter upon an investigation of the factors in nature which are represented by our conception of space.

The duration which is the immediate disclosure of our sense-awareness is discriminated into parts. There is the part which is the life of all nature within a room, and there is the part which is the life of all nature within a table in the room. These parts are limited events. They have the endurance of the present duration, and they are parts of it. But whereas a duration is an unlimited whole and in a certain limited sense is all that there is, a limited event possesses a completely defined limitation of extent which is expressed for us in spatio-temporal terms.

We are accustomed to associate an event with a certain melodramatic quality. If a man is run over, that is an event comprised within certain spatio-temporal limits. We are not accustomed to consider the endurance of the Great Pyramid throughout any definite day as an event. But the natural fact which is the Great Pyramid throughout a day, meaning thereby all nature within it, is an event of the same character as the man's accident, meaning thereby all nature with spatio-temporal limitations so as to include the man and the motor during the period when they were in contact.

We are accustomed to analyse these events into three factors, time, space, and material. In fact, we at once apply to them the concepts of the materialistic theory of nature. I do not deny the utility of this analysis for the purpose of expressing important laws of nature. What I am denying is that anyone of these factors is posited for us in sense-awareness in concrete independence. We perceive one unit factor in nature; and this factor is that something is going on then—there. For example, we perceive the going-on of the Great Pyramid in its relations to the goings-on of the surrounding Egyptian events. We are so trained, both by language and by formal teaching and by the resulting convenience, to express our thoughts in terms of this materialistic analysis that intellectually we tend to ignore the true unity of the factor really exhibited in sense-awareness. It is this unit factor, retaining in itself the passage of nature, which is the primary concrete element discriminated in nature. These primary factors are what I mean by events.

Events are the field of a two-termed relation, namely the relation of extension which was considered in the last lecture. Events are the things related by the relation of extension. If an event A extends over an event B, then B is 'part of' A, and A is a 'whole' of which B is a part. Whole and part are invariably used in these lectures in

this definite sense. It follows that in reference to this relation any two events A and B may have any one of four relations to each other, namely (i) A may extend over B, or (ii) B may extend over A, or (iii) A and B may both extend over some third event C, but neither over the other, or (iv) A and B may be entirely separate. These alternatives can obviously be illustrated by Euler's diagrams as they appear in logical textbooks.

The continuity of nature is the continuity of events. This continuity is merely the name for the aggregate of a variety of properties of events in connexion with the relation of extension.

In the first place, this relation is transitive; secondly, every event contains other events as parts of itself; thirdly every event is a part of other events; fourthly given any two finite events there are events each of which contains both of them as parts; and fifthly there is a special relation between events which I term 'junction.'

Two events have junction when there is a third event of which both events are parts, and which is such that no part of it is separated from both of the two given events. Thus two events with junction make up exactly one event which is in a sense their sum.

Only certain pairs of events have this property. In general any event containing two events also contains parts which are separated from both events.

There is an alternative definition of the junction of two events which I have adopted in my recent book.* Two events have junction when there is a third event such that (i) it overlaps both events and (ii) it has no part which is separated from both the given events. If either of these alternative definitions is adopted as the definition of junction, the other definition appears as an axiom respecting the character of junction as we know it in nature. But we are not thinking of logical definition so much as the formulation of the results of direct observation. There is a certain continuity inherent in the observed unity of an event, and these two definitions of junction are really axioms based on observation respecting the character of this continuity.

The relations of whole and part and of overlapping are particular cases of the junction of events. But it is possible for events to have

* Cf. *Enquiry*.

junction when they are separate from each other; for example, the upper and the lower part of the Great Pyramid are divided by some imaginary horizontal plane.

The continuity which nature derives from events has been obscured by the illustrations which I have been obliged to give. For example I have taken the existence of the Great Pyramid as a fairly well-known fact to which I could safely appeal as an illustration. This is a type of event which exhibits itself to us as the situation of a recognisable object; and in the example chosen the object is so widely recognised that it has received a name. An object is an entity of a different type from an event. For example, the event which is the life of nature within the Great Pyramid yesterday and to-day is divisible into two parts, namely the Great Pyramid yesterday and the Great Pyramid to-day. But the recognisable object which is also called the Great Pyramid is the same object to-day as it was yesterday. I shall have to consider the theory of objects in another lecture.

The whole subject is invested with an unmerited air of subtlety by the fact that when the event is the situation of a well-marked object, we have no language to distinguish the event from the object. In the case of the Great Pyramid, the object is the perceived unit entity which as perceived remains self-identical throughout the ages; while the whole dance of molecules and the shifting play of the electromagnetic field are ingredients of the event. An object is in a sense out of time. It is only derivatively in time by reason of its having the relation to events which I term 'situation.' This relation of situation will require discussion in a subsequent lecture.

The point which I want to make now is that being the situation of a well-marked object is not an inherent necessity for an event. Wherever and whenever something is going on, there is an event. Furthermore 'wherever and whenever' in themselves presuppose an event, for space and time in themselves are abstractions from events. It is therefore a consequence of this doctrine that something is always going on everywhere, even in so-called empty space. This conclusion is in accord with modern physical science which presupposes the play of an electromagnetic field throughout space and time. This doctrine of science has been thrown into the materialistic form of an all-pervading ether. But the ether is evidently a mere idle concept —in the phraseology which Bacon applied to the doctrine of final

causes, it is a barren virgin. Nothing is deduced from it; and the ether merely subserves the purpose of satisfying the demands of the materialistic theory. The important concept is that of the shifting facts of the fields of force. This is the concept of an ether of events which should be substituted for that of a material ether.

It requires no illustration to assure you that an event is a complex fact, and the relations between two events form an almost impenetrable maze. The clue discovered by the common sense of mankind and systematically utilised is what I have elsewhere * called the law of convergence to simplicity by diminution of extent.

If A and B are two events, and A' is part of A and B' is part of B, then in many respects the relations between the parts A' and B' will be simpler than the relations between A and B. This is the principle which presides over all attempts at exact observation.

The first outcome of the systematic use of this law has been the formulation of the abstract concepts of Time and Space. In the previous lecture I sketched how the principle was applied to obtain the time-series. I now proceed to consider how the spatial entities are obtained by the same method. The systematic procedure is identical in principle in both cases, and I have called the general type of procedure the 'method of extensive abstraction.'

You will remember that in my last lecture I defined the concept of an abstractive set of durations. This definition can be extended so as to apply to any events, limited events as well as durations. The only change that is required is the substitution of the word 'event' for the word 'duration.' Accordingly an abstractive set of events is any set of events which possesses the two properties, (i) of any two members of the set one contains the other as a part, and (ii) there is no event which is a common part of every member of the set. Such a set, as you will remember, has the properties of the Chinese toy which is a nest of boxes, one within the other, with the difference that the toy has a smallest box, while the abstractive class has neither a smallest event nor does it converge to a limiting event which is not a member of the set.

Thus, so far as the abstractive sets of events are concerned, an abstractive set converges to nothing. There is the set with its members

* Cf. *Organisation of Thought,* pp. 146 *et seq.* (Williams and Norgate, 1917).

growing indefinitely smaller and smaller as we proceed in thought towards the smaller end of the series; but there is no absolute minimum of any sort which is finally reached. In fact the set is just itself and indicates nothing else in the way of events, except itself. But each event has an intrinsic character in the way of being a situation of objects and of having parts which are situations of objects and—to state the matter more generally—in the way of being a field of the life of nature. This character can be defined by quantitative expressions expressing relations between various quantities intrinsic to the event or between such quantities and other quantities intrinsic to other events. In the case of events of considerable spatio-temporal extension this set of quantitative expressions is of bewildering complexity. If e be an event, let us denote by $q(e)$ the set of quantitative expressions defining its character including its connexions with the rest of nature. Let e_1, e_2, e_3, etc. be an abstractive set, the members being so arranged that each member such as e_n extends over all the succeeding members such as e_{n+1}, e_{n+2}, and so on. Then corresponding to the series

$$e_1, e_2, e_3, \ldots, e_n, e_{n+1}, \ldots,$$

there is the series

$$q\,(e_1), q\,(e_2), q\,(e_3), \ldots, q\,(e_n), q\,(e_{n+1}), \ldots.$$

Call the series of events s and the series of quantitative expressions $q(s)$. The series s has no last term and no events which are contained in every member of the series. Accordingly the series of events converges to nothing. It is just itself. Also the series $q(s)$ has no last term. But the sets of homologous quantities running through the various terms of the series do converge to definite limits. For example if Q_1 be a quantitative measurement found in $q(e_1)$, and Q_2 the homologue to Q_1 to be found in $q(e_2)$, and Q_3 the homologue to Q_1 and Q_2 to be found in $q(e_3)$, and so on, then the series

$$Q_1, Q_2, Q_3, \ldots, Q_n, Q_{n+1}, \ldots,$$

though it has no last term, does in general converge to a definite limit. Accordingly there is a class of limits $l(s)$ which is the class of the limits of those members of $q(e_n)$ which have homologues throughout the series $q(s)$ as n indefinitely increases. We can represent this

statement diagrammatically by using an arrow (→) to mean 'converges to.' Then

$$e_1, e_2, e_3, \ldots, e_n, e_{n+1}, \ldots \rightarrow \text{nothing},$$

and

$$q(e_1), q(e_2), q(e_3), \ldots, q(e_n), q(e_{n+1}), \ldots \rightarrow l(s).$$

The mutual relations between the limits in the set $l(s)$, and also between these limits and the limits in other sets $l(s')$, $l(s'')$, ..., which arise from other abstractive sets s', s'', etc., have a peculiar simplicity.

Thus the set s does indicate an ideal simplicity of natural relations, though this simplicity is not the character of any actual event in s. We can make an approximation to such a simplicity which, as estimated numerically, is as close as we like by considering an event which is far enough down the series towards the small end. It will be noted that it is the infinite series, as it stretches away in unending succession towards the small end, which is of importance. The arbitrarily large event with which the series starts has no importance at all. We can arbitrarily exclude any set of events at the big end of an abstractive set without the loss of any important property to the set as thus modified.

I call the limiting character of natural relations which is indicated by an abstractive set, the 'intrinsic character' of the set; also the properties, connected with the relation of whole and part as concerning its members, by which an abstractive set is defined, together form what I call its 'extrinsic character.' The fact that the extrinsic character of an abstractive set determines a definite intrinsic character is the reason of the importance of the precise concepts of space and time. This emergence of a definite intrinsic character from an abstractive set is the precise meaning of the law of convergence.

For example, we see a train approaching during a minute. The event which is the life of nature within that train during the minute is of great complexity and the expression of its relations and of the ingredients of its character baffles us. If we take one second of that minute, the more limited event which is thus obtained is simpler in respect to its ingredients, and shorter and shorter times such as a tenth of that second, or a hundredth, or a thousandth—so long as we have a definite rule giving a definite succession of diminishing

events—give events whose ingredient characters converge to the ideal simplicity of the character of the train at a definite instant. Furthermore there are different types of such convergence to simplicity. For example, we can converge as above to the limiting character expressing nature at an instant within the whole volume of the train at that instant, or to nature at an instant within some portion of that volume—for example within the boiler of the engine—or to nature at an instant on some area of surface, or to nature at an instant on some line within the train, or to nature at an instant at some point of the train. In the last case the simple limiting characters arrived at will be expressed as densities, specific gravities, and types of material. Furthermore we need not necessarily converge to an abstraction which involves nature at an instant. We may converge to the physical ingredients of a certain point track throughout the whole minute. Accordingly there are different types of extrinsic character of convergence which lead to the approximation to different types of intrinsic characters as limits.

We now pass to the investigation of possible connexions between abstractive sets. One set may 'cover' another. I define 'covering' as follows: An abstractive set p covers an abstractive set q when every member of p contains as its parts some members of q. It is evident that if any event e contains as a part any member of the set q, then owing to the transitive property of extension every succeeding member of the small end of q is part of e. In such a case I will say that the abstractive set q 'inheres in' the event e. Thus when an abstractive set p covers an abstractive set q, the abstractive set q inheres in every member of p.

Two abstractive sets may each cover the other. When this is the case I shall call the two sets 'equal in abstractive force.' When there is no danger of misunderstanding I shall shorten this phrase by simply saying that the two abstractive sets are 'equal.' The possibility of this equality of abstractive sets arises from the fact that both sets, p and q, are infinite series towards their small ends. Thus the equality means, that given any event x belonging to p, we can always by proceeding far enough towards the small end of q find an event y which is part of x, and that then by proceeding far enough towards the small end of p we can find an event z which is part of y, and so on indefinitely.

The importance of the equality of abstractive sets arises from the assumption that the intrinsic characters of the two sets are identical. If this were not the case exact observation would be at an end.

It is evident that any two abstractive sets which are equal to a third abstractive set are equal to each other. An 'abstractive element' is the whole group of abstractive sets which are equal to any one of themselves. Thus all abstractive sets belonging to the same element are equal and converge to the same intrinsic character. Thus an abstractive element is the group of routes of approximation to a definite intrinsic character of ideal simplicity to be found as a limit among natural facts.

If an abstractive set p covers an abstractive set q, then any abstractive set belonging to the abstractive element of which p is a member will cover any abstractive set belonging to the element of which q is a member. Accordingly it is useful to stretch the meaning of the term 'covering,' and to speak of one abstractive element 'covering' another abstractive element. If we attempt in like manner to stretch the term 'equal' in the sense of 'equal in abstractive force,' it is obvious that an abstractive element can only be equal to itself. Thus an abstractive element has a unique abstractive force and is the construct from events which represents one definite intrinsic character which is arrived at as a limit by the use of the principle of convergence to simplicity by diminution of extent.

When an abstractive element A covers an abstractive element B, the intrinsic character of A in a sense includes the intrinsic character of B. It results that statements about the intrinsic character of B are in a sense statements about the intrinsic character of A; but the intrinsic character of A is more complex than that of B.

The abstractive elements form the fundamental elements of space and time, and we now turn to the consideration of the properties involved in the formation of special classes of such elements. In my last lecture I have already investigated one class of abstractive elements, namely moments. Each moment is a group of abstractive sets, and the events which are members of these sets are all members of one family of durations. The moments of one family form a temporal series; and, allowing the existence of different families of moments, there will be alternative temporal series in nature. Thus the method of extensive abstraction explains the origin of temporal series in terms

of the immediate facts of experience and at the same time allows for the existence of the alternative temporal series which are demanded by the modern theory of electromagnetic relativity.

We now turn to space. The first thing to do is to get hold of the class of abstractive elements which are in some sense the points of space. Such an abstractive element must in some sense exhibit a convergence to an absolute minimum of intrinsic character. Euclid has expressed for all time the general idea of a point, as being without parts and without magnitude. It is this character of being an absolute minimum which we want to get at and to express in terms of the extrinsic characters of the abstractive sets which make up a point. Furthermore, points which are thus arrived at represent the ideal of events without any extension, though there are in fact no such entities as these ideal events. These points will not be the points of an external timeless space but of instantaneous spaces. We ultimately want to arrive at the timeless space of physical science, and also of common thought which is now tinged with the concepts of science. It will be convenient to reserve the term 'point' for these spaces when we get to them. I will therefore use the name 'event-particles' for the ideal minimum limits to events. Thus an event-particle is an abstractive element and as such is a group of abstractive sets; and a point—namely a point of timeless space—will be a class of event-particles.

Furthermore there is a separate timeless space corresponding to each separate temporal series, that is to each separate family of durations. We will come back to points in timeless spaces later. I merely mention them now that we may understand the stages of our investigation. The totality of event-particles will form a four-dimensional manifold, the extra dimension arising from time—in other words—arising from the points of a timeless space being each a class of event-particles.

The required character of the abstractive sets which form event-particles would be secured if we could define them as having the property of being covered by any abstractive set which they cover. For then any other abstractive set which an abstractive set of an event-particle covered, would be equal to it, and would therefore be a member of the same event-particle. Accordingly an event-particle could cover no other abstractive element. This is the definition which I originally proposed at a congress in Paris in 1914.* There is how-

* Cf. 'La Théorie Relationniste de l'Espace,' *Rev. de Métaphysique et de Morale,* vol. XXIII (1916).

ever a difficulty involved in this definition if adopted without some further addition, and I am now not satisfied with the way in which I attempted to get over that difficulty in the paper referred to.

The difficulty is this: When event-particles have once been defined it is easy to define the aggregrate of event-particles forming the boundary of an event; and thence to define the point-contact at their boundaries possible for a pair of events of which one is part of the other. We can then conceive all the intricacies of tangency. In particular we can conceive an abstractive set of which all the members have point-contact at the same event-particle. It is then easy to prove that there will be no abstractive set with the property of being covered by every abstractive set which it covers. I state this difficulty at some length because its existence guides the development of our line of argument. We have got to annex some condition to the root property of being covered by any abstractive set which it covers. When we look into this question of suitable conditions we find that in addition to event-particles all the other relevant spatial and spatio-temporal abstractive elements can be defined in the same way by suitably varying the conditions. Accordingly we proceed in a general way suitable for employment beyond event-particles.

Let σ be the name of any condition which some abstractive sets fulfil. I say that an abstractive set is 'σ-prime' when it has the two properties, (i) that it satisfies the condition σ and (ii) that it is covered by every abstractive set which both is covered by it and satisfies the condition σ.

In other words you cannot get any abstractive set satisfying the condition σ which exhibits intrinsic character more simple than that of a σ-prime.

There are also the correlative abstractive sets which I call the sets of σ-antiprimes. An abstractive set is a σ-antiprime when it has the two properties, (i) that it satisfies the condition σ and (ii) that it covers every abstractive set which both covers it and satisfies the condition σ. In other words you cannot get any abstractive set satisfying the condition σ which exhibits an intrinsic character more complex than that of a σ-antiprime.

The intrinsic character of a σ-prime has a certain minimum of fullness among those abstractive sets which are subject to the condition of satisfying σ; whereas the intrinsic character of a σ-antiprime has a corresponding maximum of fullness, and includes all it can in the circumstances.

Let us first consider what help the notion of antiprimes could give us in the definition of moments which we gave in the last lecture. Let the condition σ be the property of being a class whose members are all durations. An abstractive set which satisfies this condition is thus an abstractive set composed wholly of durations. It is convenient then to define a moment as the group of abstractive sets which are equal to some σ-antiprime, where the condition σ has this special meaning. It will be found on consideration (i) that each abstractive set forming a moment is a σ-antiprime, where σ has this special meaning, and (ii) that we have excluded from membership of moments abstractive sets of durations which all have one common boundary, either the initial boundary or the final boundary. We thus exclude special cases which are apt to confuse general reasoning. The new definition of a moment, which supersedes our previous definition, is (by the aid of the notion of antiprimes) the more precisely drawn of the two, and the more useful.

The particular condition which 'σ' stood for in the definition of moments included something additional to anything which can be derived from the bare notion of extension. A duration exhibits for thought a totality. The notion of totality is something beyond that of extension, though the two are interwoven in the notion of a duration.

In the same way the particular condition 'σ' required for the definition of an event-particle must be looked for beyond the mere notion of extension. The same remark is also true of the particular conditions requisite for the other spatial elements. This additional notion is obtained by distinguishing between the notion of 'position' and the notion of convergence to an ideal zero of extension as exhibited by an abstractive set of events.

In order to understand this distinction consider a point of the instantaneous space which we conceive as apparent to us in an almost instantaneous glance. This point is an event-particle. It has two aspects. In one aspect it is there, where it is. This is its position in the space. In another aspect it is got at by ignoring the circumambient space, and by concentrating attention on the smaller and smaller set of events which approximate to it. This is its extrinsic character. Thus a point has three characters, namely, its position in the whole instantaneous space, its extrinsic character, and its intrinsic character. The same is true of any other spatial element. For example an instantaneous volume in instantaneous space has three characters,

namely, its position, its extrinsic character as a group of abstractive sets, and its intrinsic character which is the limit of natural properties which is indicated by any one of these abstractive sets.

Before we can talk about position in instantaneous space, we must evidently be quite clear as to what we mean by instantaneous space in itself. Instantaneous space must be looked for as a character of a moment. For a moment is all nature at an instant. It cannot be the intrinsic character of the moment. For the intrinsic character tells us the limiting character of nature in space at that instant. Instantaneous space must be an assemblage of abstractive elements considered in their mutual relations. Thus an instantaneous space is the assemblage of abstractive elements covered by some one moment, and it is the instantaneous space of that moment.

We have now to ask what character we have found in nature which is capable of according to the elements of an instantaneous space different qualities of position. This question at once brings us to the intersection of moments, which is a topic not as yet considered in these lectures.

The locus of intersection of two moments is the assemblage of abstractive elements covered by both of them. Now two moments of the same temporal series cannot intersect. Two moments respectively of different families necessarily intersect. Accordingly in the instantaneous space of a moment we should expect the fundamental properties to be marked by the intersections with moments of other families. If M be a given moment, the intersection of M with another moment A is an instantaneous plane in the instantaneous space of M; and if B be a third moment intersecting both M and A, the intersection of M and B is another plane in the space M. Also the common intersection of A, B, and M is the intersection of the two planes in the space M, namely it is a straight line in the space M. An exceptional case arises if B and M intersect in the same plane as A and M. Furthermore if C be a fourth moment, then apart from special cases which we need not consider, it intersects M in a plane which the straight line (A, B, M) meets. Thus there is in general a common intersection of four moments of different families. This common intersection is an assemblage of abstractive elements which are each covered (or 'lie in') all four moments. The three-dimensional property of instantaneous space comes to this, that (apart from special relations between the four moments) any fifth moment either con-

tains the whole of their common intersection or none of it. No further subdivision of the common intersection is possible by means of moments. The 'all or none' principle holds. This is not an *à priori* truth but an empirical fact of nature.

It will be convenient to reserve the ordinary spatial terms 'plane,' 'straight line,' 'point' for the elements of the timeless space of a time-system. Accordingly an instantaneous plane in the instantaneous space of a moment will be called a 'level,' an instantaneous straight line will be called a 'rect,' and an instantaneous point will be called a 'punct.' Thus a punct is the assemblage of abstractive elements which lie in each of four moments whose families have no special relations to each other. Also if P be any moment, either every abstractive element belonging to a given punct lies in P, or no abstractive element of that punct lies in P.

Position is the quality which an abstractive element possesses in virtue of the moments in which it lies. The abstractive elements which lie in the instantaneous space of a given moment M are differentiated from each other by the various other moments which intersect M so as to contain various selections of these abstractive elements. It is this differentiation of the elements which constitutes their differentiation of position. An abstractive element which belongs to a punct has the simplest type of position in M, an abstractive element which belongs to a rect but not to a punct has a more complex quality of position, an abstractive element which belongs to a level and not to a rect has a still more complex quality of position, and finally the most complex quality of position belongs to an abstractive element which belongs to a volume and not to a level. A volume however has not yet been defined. This definition will be given in the next lecture.

Evidently levels, rects, and puncts in their capacity as infinite aggregates cannot be the termini of sense-awareness, nor can they be limits which are approximated to in sense-awareness. Any one member of a level has a certain quality arising from its character as also belonging to a certain set of moments, but the level as a whole is a mere logical notion without any route of approximation along entities posited in sense-awareness.

On the other hand an event-particle is defined so as to exhibit this character of being a route of approximation marked out by entities posited in sense-awareness. A definite event-particle is defined

in reference to a definite punct in the following manner: Let the condition σ mean the property of covering all the abstractive elements which are members of that punct; so that an abstractive set which satisfies the condition σ is an abstractive set which covers every abstractive element belonging to the punct. Then the definition of the event-particle associated with the punct is that it is the group of all the σ-primes, where σ has this particular meaning.

It is evident that—with this meaning of σ—every abstractive set equal to a σ-prime is itself a σ-prime. Accordingly an event-particle as thus defined is an abstractive element, namely it is the group of those abstractive sets which are each equal to some given abstractive set. If we write out the definition of the event-particle associated with some given punct, which we will call π, it is as follows: The event-particle associated with π is the group of abstractive classes each of which has the two properties (i) that it covers every abstractive set in π and (ii) that all the abstractive sets which also satisfy the former condition as to π and which it covers, also cover it.

An event-particle has position by reason of its association with a punct, and conversely the punct gains its derived character as a route of approximation from its association with the event-particle. These two characters of a point are always recurring in any treatment of the derivation of a point from the observed facts of nature, but in general there is no clear recognition of their distinction.

The peculiar simplicity of an instantaneous point has a twofold origin, one connected with position, that is to say with its character as a punct, and the other connected with its character as an event-particle. The simplicity of the punct arises from its indivisibility by a moment.

The simplicity of an event-particle arises from the indivisibility of its intrinsic character. The intrinsic character of an event-particle is indivisible in the sense that every abstractive set covered by it exhibits the same intrinsic character. It follows that, though there are diverse abstractive elements covered by event-particles, there is no advantage to be gained by considering them since we gain no additional simplicity in the expression of natural properties.

These two characters of simplicity enjoyed respectively by event-particles and puncts define a meaning for Euclid's phrase, 'without parts and without magnitude.'

It is obviously convenient to sweep away out of our thoughts all

these stray abstractive sets which are covered by event-particles without themselves being members of them. They give us nothing new in the way of intrinsic character. Accordingly we can think of rects and levels as merely loci of event-particles. In so doing we are also cutting out those abstractive elements which cover sets of event-particles, without these elements being event-particles themselves. There are classes of these abstractive elements which are of great importance. I will consider them later on in this and in other lectures. Meanwhile we will ignore them. Also I will always speak of 'event-particles' in preference to 'puncts,' the latter being an artificial word for which I have no great affection.

Parallelism among rects and levels is now explicable.

Consider the instantaneous space belonging to a moment A, and let A belong to the temporal series of moments which I will call α. Consider any other temporal series of moments which I will call β. The moments of β do not intersect each other and they intersect the moment A in a family of levels. None of these levels can intersect, and they form a family of parallel instantaneous planes in the instantaneous space of moment A. Thus the parallelism of moments in a temporal series begets the parallelism of levels in an instantaneous space, and thence—as it is easy to see—the parallelism of rects. Accordingly the Euclidean property of space arises from the parabolic property of time. It may be that there is reason to adopt a hyperbolic theory of time and a corresponding hyperbolic theory of space. Such a theory has not been worked out, so it is not possible to judge as to the character of the evidence which could be brought forward in its favour.

The theory of order in an instantaneous space is immediately derived from time-order. For consider the space of a moment M. Let α be the name of a time-system to which M does not belong. Let A_1, A_2, A_3, etc. be moments of α in the order of their occurrences. Then A_1, A_2, A_3, etc. intersect M in parallel levels l_1, l_2, l_3, etc. Then the relative order of the parallel levels in the space of M is the same as the relative order of the corresponding moments in the time-system α. Any rect in M which intersects all these levels in its set of puncts, thereby receives for its puncts an order of position on it. So spatial order is derivative from temporal order. Furthermore there are alternative time-systems, but there is only one definite spatial order in each instantaneous space. Accordingly the various modes of deriving spatial order from diverse time-systems must harmonise

with one spatial order in each instantaneous space. In this way also diverse time-orders are comparable.

We have two great questions still on hand to be settled before our theory of space is fully adjusted. One of these is the question of the determination of the methods of measurement within the space, in other words, the congruence-theory of the space. The measurement of space will be found to be closely connected with the measurement of time, with respect to which no principles have as yet been determined. Thus our congruence-theory will be a theory both for space and for time. Secondly there is the determination of the timeless space which corresponds to any particular time-system with its infinite set of instantaneous spaces in its successive moments. This is the space—or rather, these are the spaces—of physical science. It is very usual to dismiss this space by saying that this is conceptual. I do not understand the virtue of these phrases. I suppose that it is meant that the space is the conception of something in nature. Accordingly if the space of physical science is to be called conceptual, I ask, What in nature is it the conception of? For example, when we speak of a point in the timeless space of physical science, I suppose that we are speaking of something in nature. If we are not so speaking, our scientists are exercising their wits in the realms of pure fantasy, and this is palpably not the case. This demand for a definite Habeas Corpus Act for the production of the relevant entities in nature applies whether space be relative or absolute. On the theory of relative space, it may perhaps be argued that there is no timeless space for physical science, and that there is only the momentary series of instantaneous spaces.

An explanation must then be asked for the meaning of the very common statement that such and such a man walked four miles in some definite hour. How can you measure distance from one space into another space? I understand walking out of the sheet of an ordnance map. But the meaning of saying that Cambridge at 10 o'clock this morning in the appropriate instantaneous space for that instant is 52 miles from London at 11 o'clock this morning in the appropriate instantaneous space for that instant beats me entirely. I think that, by the time a meaning has been produced for this statement, you will find that you have constructed what is in fact a timeless space. What I cannot understand is how to produce an explanation of meaning without in effect making some such construction. Also I may add that I do not know how the instantaneous spaces are

thus correlated into one space by any method which is available on the current theories of space.

You will have noticed that by the aid of the assumption of alternative time-systems, we are arriving at an explanation of the character of space. In natural science 'to explain' means merely to discover 'interconnexions.' For example, in one sense there is no explanation of the red which you see. It is red, and there is nothing else to be said about it. Either it is posited before you in sense-awareness or you are ignorant of the entity red. But science has explained red. Namely it has discovered interconnexions between red as a factor in nature and other factors in nature, for example waves of light which are waves of electromagnetic disturbances. There are also various pathological states of the body which lead to the seeing of red without the occurrence of light waves. Thus connexions have been discovered between red as posited in sense-awareness and various other factors in nature. The discovery of these connexions constitutes the scientific explanation of our vision of colour. In like manner the dependence of the character of space on the character of time constitutes an explanation in the sense in which science seeks to explain. The systematising intellect abhors bare facts. The character of space has hitherto been presented as a collection of bare facts, ultimate and disconnected. The theory which I am expounding sweeps away this disconnexion of the facts of space.

CHAPTER V *SPACE AND MOTION*

The topic for this lecture is the continuation of the task of explaining the construction of spaces as abstracts from the facts of nature. It was noted at the close of the previous lecture that the question of congruence had not been considered, nor had the construction of a timeless space which should correlate the successive momentary spaces of a given time-system. Furthermore it was also noted that there were many spatial abstractive elements which we had not yet defined. We will first consider the definition of some of these abstractive elements, namely the definitions of solids, of areas, and of routes. By a 'route' I mean a linear segment, whether straight or curved. The exposition of these definitions and the preliminary ex-

planations necessary will, I hope, serve as a general explanation of the function of event-particles in the analysis of nature.

We note that event-particles have 'position' in respect to each other. In the last lecture I explained that 'position' was quality gained by a spatial element in virtue of the intersecting moments which covered it. Thus each event-particle has position in this sense. The simplest mode of expressing the position in nature of an event-particle is by first fixing on any definite time-system. Call it α. There will be one moment of the temporal series of α which covers the given event-particle. Thus the position of the event-particle in the temporal series α is defined by this moment, which we will call M. The position of the particle in the space of M is then fixed in the ordinary way by three levels which intersect in it and in it only. This procedure of fixing the position of an event-particle shows that the aggregate of event-particles forms a four-dimensional manifold. A finite event occupies a limited chunk of this manifold in a sense which I now proceed to explain.

Let e be any given event. The manifold of event-particles falls into three sets in reference to e. Each event-particle is a group of equal abstractive sets and each abstractive set towards its small-end is composed of smaller and smaller finite events. When we select from these finite events which enter into the make-up of a given event-particle those which are small enough, one of three cases must occur. Either (i) all of these small events are entirely separate from the given event e, or (ii) all of these small events are parts of the event e, or (iii) all of these small events overlap the event e but are not parts of it. In the first case the event-particle will be said to 'lie outside' the event e, in the second case the event-particle will be said to 'lie inside' the event e, and in the third case the event-particle will be said to be a 'boundary-particle' of the event e. Thus there are three sets of particles, namely the set of those which lie outside the event e, the set of those which lie inside the event e, and the boundary of the event e which is the set of boundary-particles of e. Since an event is four-dimensional, the boundary of an event is a three-dimensional manifold. For a finite event there is a continuity of boundary; for a duration the boundary consists of those event-particles which are covered by either of the two bounding moments. Thus the boundary of a duration consists of two momentary three-dimensional spaces. An event will be said to 'occupy' the aggregate of event-particles which lie within it.

Two events which have 'junction' in the sense in which junction was described in my last lecture, and yet are separated so that neither event either overlaps or is part of the other event, are said to be 'adjoined.'

This relation of adjunction issues in a peculiar relation between the boundaries of the two events. The two boundaries must have a common portion which is in fact a continuous three-dimensional locus of event-particles in the four-dimensional manifold.

A three-dimensional locus of event-particles which is the common portion of the boundary of two adjoined events will be called a 'solid.' A solid may or may not lie completely in one moment. A solid which does not lie in one moment will be called 'vagrant.' A solid which does lie in one moment will be called a volume. A volume may be defined as the locus of the event-particles in which a moment intersects an event, provided that the two do intersect. The intersection of a moment and an event will evidently consist of those event-particles which are covered by the moment and lie in the event. The identity of the two definitions of a volume is evident when we remember that an intersecting moment divides the event into two adjoined events.

A solid as thus defined, whether it be vagrant or be a volume, is a mere aggregate of event-particles illustrating a certain quality of position. We can also define a solid as an abstractive element. In order to do so we recur to the theory of primes explained in the preceding lecture. Let the condition named σ stand for the fact that each of the events of any abstractive set satisfying it has all the event-particles of some particular solid lying in it. Then the group of all the σ-primes is the abstractive element which is associated with the given solid. I will call this abstractive element the solid as an abstractive element, and I will call the aggregate of event-particles the solid as a locus. The instantaneous volumes in instantaneous space which are the ideals of our sense-perception are volumes as abstractive elements. What we really perceive with all our efforts after exactness are small events far enough down some abstractive set belonging to the volume as an abstractive element.

It is difficult to know how far we approximate to any perception of vagrant solids. We certainly do not think that we make any such approximation. But then our thoughts—in the case of people who do think about such topics—are so much under the control of the

materialistic theory of nature that they hardly count for evidence. If Einstein's theory of gravitation has any truth in it, vagrant solids are of great importance in science. The whole boundary of a finite event may be looked on as a particular example of a vagrant solid as a locus. Its particular property of being closed prevents it from being definable as an abstractive element.

When a moment intersects an event, it also intersects the boundary of that event. This locus, which is the portion of the boundary contained in the moment, is the bounding surface of the corresponding volume of that event contained in the moment. It is a two-dimensional locus.

The fact that every volume has a bounding surface is the origin of the Dedekindian continuity of space.

Another event may be cut by the same moment in another volume and this volume will also have its boundary. These two volumes in the instantaneous space of one moment may mutually overlap in the familiar way which I need not describe in detail and thus cut off portions from each other's surfaces. These portions of surfaces are 'momental areas.'

It is unnecessary at this stage to enter into the complexity of a definition of vagrant areas. Their definition is simple enough when the four-dimensional manifold of event-particles has been more fully explored as to its properties.

Momental areas can evidently be defined as abstractive elements by exactly the same method as applied to solids. We have merely to substitute 'area' for a 'solid' in the words of the definition already given. Also, exactly as in the analogous case of a solid, what we perceive as an approximation to our ideal of an area is a small event far enough down towards the small end of one of the equal abstractive sets which belongs to the area as an abstractive element.

Two momental areas lying in the same moment can cut each other in a momental segment which is not necessarily rectilinear. Such a segment can also be defined as an abstractive element. It is then called a 'momental route.' We will not delay over any general consideration of these momental routes, nor is it important for us to proceed to the still wider investigation of vagrant routes in general. There are however two simple sets of routes which are of vital importance. One is a set of momental routes and the other of vagrant routes. Both sets can be classed together as straight routes. We

proceed to define them without any reference to the definitions of volumes and surfaces.

The two types of straight routes will be called rectilinear routes and stations. Rectilinear routes are momental routes and stations are vagrant routes. Rectilinear routes are routes which in a sense lie in rects. Any two event-particles on a rect define the set of event-particles which lie between them on that rect. Let the satisfaction of the condition σ by an abstractive set mean that the two given event-particles and the event-particles lying between them on the rect all lie in every event belonging to the abstractive set. The group of σ-primes, where σ has this meaning, form an abstractive element. Such abstractive elements are rectilinear routes. They are the segments of instantaneous straight lines which are the ideals of exact perception. Our actual perception, however exact, will be the perception of a small event sufficiently far down one of the abstractive sets of the abstractive element.

A station is a vagrant route and no moment can intersect any station in more than one event-particle. Thus a station carries with it a comparison of the positions in their respective moments of the event-particles covered by it. Rects arise from the intersection of moments. But as yet no properties of events have been mentioned by which any analogous vagrant loci can be found out.

The general problem for our investigation is to determine a method of comparison of position in one instantaneous space with positions in other instantaneous spaces. We may limit ourselves to the spaces of the parallel moments of one time-system. How are positions in these various spaces to be compared? In other words, What do we mean by motion? It is the fundamental question to be asked of any theory of relative space, and like many other fundamental questions it is apt to be left unanswered. It is not an answer to reply, that we all know what we mean by motion. Of course we do, so far as sense-awareness is concerned. I am asking that your theory of space should provide nature with something to be observed. You have not settled the question by bringing forward a theory according to which there is nothing to be observed, and by then reiterating that nevertheless we do observe this non-existent fact. Unless motion is something as a fact in nature, kinetic energy and momentum and all that depends on these physical concepts evaporate from our list of physical realities. Even in this revolutionary age my

conservatism resolutely opposes the identification of momentum and moonshine.

Accordingly I assume it as an axiom, that motion is a physical fact. It is something that we perceive as in nature. Motion presupposes rest. Until theory arose to vitiate immediate intuition, that is to say to vitiate the uncriticised judgments which immediately arise from sense-awareness, no one doubted that in motion you leave behind that which is at rest. Abraham in his wanderings left his birthplace where it had ever been. A theory of motion and a theory of rest are the same thing viewed from different aspects with altered emphasis.

Now you cannot have a theory of rest without in some sense admitting a theory of absolute position. It is usually assumed that relative space implies that there is no absolute position. This is, according to my creed, a mistake. The assumption arises from the failure to make another distinction; namely, that there may be alternative definitions of absolute position. This possibility enters with the admission of alternative time-systems. Thus the series of spaces in the parallel moments of one temporal series may have their own definition of absolute position correlating sets of event-particles in these successive spaces, so that each set consists of event-particles, one from each space, all with the property of possessing the same absolute position in that series of spaces. Such a set of event-particles will form a point in the timeless space of that time-system. Thus a point is really an absolute position in the timeless space of a given time-system.

But there are alternative time-systems, and each time-system has its own peculiar group of points—that is to say, its own peculiar definition of absolute position. This is exactly the theory which I will elaborate.

In looking to nature for evidence of absolute position it is of no use to recur to the four-dimensional manifold of event-particles. This manifold has been obtained by the extension of thought beyond the immediacy of observation. We shall find nothing in it except what we have put there to represent the ideas in thought which arise from our direct sense-awareness of nature. To find evidence of the properties which are to be found in the manifold of event-particles we must always recur to the observation of relations between events. Our problem is to determine those relations between events which issue in the property of absolute position in a timeless space. This is

in fact the problem of the determination of the very meaning of the timeless spaces of physical science.

In reviewing the factors of nature as immediately disclosed in sense-awareness, we should note the fundamental character of the percept of 'being here.' We discern an event merely as a factor in a determinate complex in which each factor has its own peculiar share.

There are two factors which are always ingredient in this complex, one is the duration which is represented in thought by the concept of all nature that is present now, and the other is the peculiar *locus standi* for mind involved in the sense-awareness. This *locus standi* in nature is what is represented in thought by the concept of 'here,' namely of an 'event here.'

This is the concept of a definite factor in nature. This factor is an event in nature which is the focus in nature for that act of awareness, and the other events are perceived as referred to it. This event is part of the associated duration. I call it the 'percipient event.' This event is not the mind, that is to say, not the percipient. It is that in nature from which the mind perceives. The complete foothold of the mind in nature is represented by the pair of events, namely, the present duration which marks the 'when' of awareness and the percipient event which marks the 'where' of awareness and the 'how' of awareness. This percipient event is roughly speaking the bodily life of the incarnate mind. But this identification is only a rough one. For the functions of the body shade off into those of other events in nature; so that for some purposes the percipient event is to be reckoned as merely part of the bodily life and for other purposes it may even be reckoned as more than the bodily life. In many respects the demarcation is purely arbitrary, depending upon where in a sliding scale you choose to draw the line.

I have already in my previous lecture on Time discussed the association of mind with nature. The difficulty of the discussion lies in the liability of constant factors to be overlooked. We never note them by contrast with their absences. The purpose of a discussion of such factors may be described as being to make obvious things look odd. We cannot envisage them unless we manage to invest them with some of the freshness which is due to strangeness.

It is because of this habit of letting constant factors slip from consciousness that we constantly fall into the error of thinking of the sense-awareness of a particular factor in nature as being a two-

termed relation between the mind and the factor. For example, I perceive a green leaf. Language in this statement suppresses all reference to any factors other than the percipient mind and the green leaf and the relation of sense-awareness. It discards the obvious inevitable factors which are essential elements in the perception. I am here, the leaf is there; and the event here and the event which is the life of the leaf there are both embedded in a totality of nature which is now, and within this totality there are other discriminated factors which it is irrelevant to mention. Thus language habitually sets before the mind a misleading abstract of the indefinite complexity of the fact of sense-awareness.

What I now want to discuss is the special relation of the percipient event which is 'here' to the duration which is 'now.' This relation is a fact in nature, namely the mind is aware of nature as being with these two factors in this relation.

Within the short present duration the 'here' of the percipient event has a definite meaning of some sort. This meaning of 'here' is the content of the special relation of the percipient event to its associated duration. I will call this relation 'cogredience.' Accordingly I ask for a description of the character of the relation of cogredience. The present snaps into a past and a present when the 'here' of cogredience loses its single determinate meaning. There has been a passage of nature from the 'here' of perception within the past duration to the different 'here' of perception within the present duration. But the two 'heres' of sense-awareness within neighbouring durations may be indistinguishable. In this case there has been a passage from the past to the present, but a more retentive perceptive force might have retained the passing nature as one complete present instead of letting the earlier duration slip into the past. Namely, the sense of rest helps the integration of durations into a prolonged present, and the sense of motion differentiates nature into a succession of shortened durations. As we look out of a railway carriage in an express train, the present is past before reflexion can seize it. We live in snippits too quick for thought. On the other hand the immediate present is prolonged according as nature presents itself to us in an aspect of unbroken rest. Any change in nature provides ground for a differentiation among durations so as to shorten the present. But there is a great distinction between self-change in nature and change in external nature. Self-change in nature is change in the quality of

the standpoint of the percipient event. It is the break up of the 'here' which necessitates the break up of the present duration. Change in external nature is compatible with a prolongation of the present of contemplation rooted in a given standpoint. What I want to bring out is that the preservation of a peculiar relation to a duration is a necessary condition for the function of that duration as a present duration for sense-awareness. This peculiar relation is the relation of cogredience between the percipient event and the duration. Cogredience is the preservation of unbroken quality of standpoint within the duration. It is the continuance of identity of station within the whole of nature which is the terminus of sense-awareness. The duration may comprise change within itself, but cannot—so far as it is one present duration—comprise change in the quality of its peculiar relation to the contained percipient event.

In other words, perception is always 'here,' and a duration can only be posited as present for sense-awareness on condition that it affords one unbroken meaning of 'here' in its relation to the percipient event. It is only in the past that you can have been 'there' with a standpoint distinct from your present 'here.'

Events there and events here are facts of nature, and the qualities of being 'there' and 'here' are not merely qualities of awareness as a relation between nature and mind. The quality of determinate station in the duration which belongs to an event which is 'here' in one determinate sense of 'here' is the same kind of quality of station which belongs to an event which is 'there' in one determinate sense of 'there.' Thus cogredience has nothing to do with any biological character of the event which is related by it to the associated duration. This biological character is apparently a further condition for the peculiar connexion of a percipient event with the percipience of mind; but it has nothing to do with the relation of the percipient event to the duration which is the present whole of nature posited as the disclosure of the percipience.

Given the requisite biological character, the event in its character of a percipient event selects that duration with which the operative past of the event is practically cogredient within the limits of the exactitude of observation. Namely, amid the alternative time-systems which nature offers there will be one with a duration giving the best average of cogredience for all the subordinate parts of the percipient event. This duration will be the whole of nature which is the

terminus posited by sense-awareness. Thus the character of the percipient event determines the time-system immediately evident in nature. As the character of the percipient event changes with the passage of nature—or, in other words, as the percipient mind in its passage correlates itself with the passage of the percipient event into another percipient event—the time-system correlated with the percipience of that mind may change. When the bulk of the events perceived are cogredient in a duration other than that of the percipient event, the percipience may include a double consciousness of cogredience, namely the consciousness of the whole within which the observer in the train is 'here,' and the consciousness of the whole within which the trees and bridges and telegraph posts are definitely 'there.' Thus in perceptions under certain circumstances the events discriminated assert their own relations of cogredience. This assertion of cogredience is peculiarly evident when the duration to which the perceived event is cogredient is the same as the duration which is the present whole of nature—in other words, when the event and the percipient event are both cogredient to the same duration.

We are now prepared to consider the meaning of stations in a duration, where stations are a peculiar kind of routes, which define absolute position in the associated timeless space.

There are however some preliminary explanations. A finite event will be said to extend throughout a duration when it is part of the duration and is intersected by any moment which lies in the duration. Such an event begins with the duration and ends with it. Furthermore every event which begins with the duration and ends with it, extends throughout the duration. This is an axiom based on the continuity of events. By beginning with a duration and ending with it, I mean (i) that the event is part of the duration, and (ii) that both the initial and final boundary moments of the duration cover some event-particles on the boundary of the event.

Every event which is cogredient with a duration extends throughout that duration.

It is not true that all the parts of an event cogredient with a duration are also cogredient with the duration. The relation of cogredience may fail in either of two ways. One reason for failure may be that the part does not extend throughout the duration. In this case the part may be cogredient with another duration which is part of the given duration, though it is not cogredient with the given dura-

tion itself. Such a part would be cogredient if its existence were sufficiently prolonged in that time-system. The other reason for failure arises from the four-dimensional extension of events so that there is no determinate route of transition of events in linear series. For example, the tunnel of a tube railway is an event at rest in a certain time-system, that is to say, it is cogredient with a certain duration. A train travelling in it is part of that tunnel, but is not itself at rest.

If an event e be cogredient with a duration d, and d' be any duration which is part of d, then d' belongs to the same time-system as d. Also d' intersects e in an event e' which is part of e and is cogredient with d'.

Let P be any event-particle lying in a given duration d. Consider the aggregate of events in which P lies and which are also cogredient with d. Each of these events occupies its own aggregate of event-particles. These aggregates will have a common portion, namely the class of event-particle lying in all of them. This class of event-particles is what I call the 'station' of the event-particle P in the duration d. This is the station in the character of a locus. A station can also be defined in the character of an abstractive element. Let the property σ be the name of the property which an abstractive set possesses when (i) each of its events is cogredient with the duration d and (ii) the event-particle P lies in each of its events. Then the group of σ-primes, where σ has this meaning, is an abstractive element and is the station of P in d as an abstractive element. The locus of event-particles covered by the station of P in d as an abstractive element is the station of P in d as a locus. A station has accordingly the usual three characters, namely, its character of position, its extrinsic character as an abstractive element, and its intrinsic character.

It follows from the peculiar properties of rest that two stations belonging to the same duration cannot intersect. Accordingly every event-particle on a station of a duration has that station as its station in the duration. Also every duration which is part of a given duration intersects the stations of the given duration in loci which are its own stations. By means of these properties we can utilise the overlappings of the durations of one family—that is, of one time-system—to prolong stations indefinitely backwards and forwards. Such a prolonged station will be called a point-track. A point-track is a locus of event-particles. It is defined by reference to one particu-

lar time-system, α say. Corresponding to any other time-system these will be a different group of point-tracks. Every event-particle will lie on one and only one point-track of the group belonging to any one time-system. The group of point-tracks of the time-system α is the group of points of the timeless space of α. Each such point indicates a certain quality of absolute position in reference to the durations of the family associated with α, and thence in reference to the successive instantaneous spaces lying in the successive moments of α. Each moment of α will intersect a point-track in one and only one event-particle.

This property of the unique intersection of a moment and a point-track is not confined to the case when the moment and the point-track belong to the same time-system. Any two event-particles on a point-track are sequential, so that they cannot lie in the same moment. Accordingly no moment can intersect a point-track more than once, and every moment intersects a point-track in one event-particle.

Anyone who at the successive moments of α should be at the event-particles where those moments intersect a given point of α will be at rest in the timeless space of time-system α. But in any other timeless space belonging to another time-system he will be at a different point at each succeeding moment of that time-system. In other words he will be moving. He will be moving in a straight line with uniform velocity. We might take this as the definition of a straight line. Namely, a straight line in the space of time-system β is the locus of those points of β which all intersect some one point-track which is a point in the space of some other time-system. Thus each point in the space of a time-system α is associated with one and only one straight line of the space of any other time-system β. Furthermore the set of straight lines in space β which are thus associated with points in space α form a complete family of parallel straight lines in space β. Thus there is a one-to-one correlation of points in space α with the straight lines of a certain definite family of parallel straight lines in space β. Conversely there is an analogous one-to-one correlation of the points in space β with the straight lines of a certain family of parallel straight lines in space α. These families will be called respectively the family of parallels in β associated with α, and the family of parallels in α associated with β. The direction in the space of β indicated by the family of parallels in β will be called the

direction of α in space β, and the family of parallels in α is the direction of β in space α. Thus a being at rest at a point of space α will be moving uniformly along a line in space β which is in the direction of α in space β, and a being at rest at a point of space β will be moving uniformly along a line in space α which is in the direction of β in space α.

I have been speaking of the timeless spaces which are associated with time-systems. These are the spaces of physical science and of any concept of space as eternal and unchanging. But what we actually perceive is an approximation to the instantaneous space indicated by event-particles which lie within some moment of the time-system associated with our awareness. The points of such an instantaneous space are event-particles and the straight lines are rects. Let the time-system be named α, and let the moment of time-system α to which our quick perception of nature approximates be called M. Any straight line r in space α is a locus of points and each point is a point-track which is a locus of event-particles. Thus in the four-dimensional geometry of all event-particles there is a two-dimensional locus which is the locus of all event-particles on points lying on the straight line r. I will call this locus of event-particles the matrix of the straight line r. A matrix intersects any moment in a rect. Thus the matrix of r intersects the moment M in a rect ρ. Thus ρ is the instantaneous rect in M which occupies at the moment M the straight line r in the space of α. Accordingly when one sees instantaneously a moving being and its path ahead of it, what one really sees is the being at some event-particle A lying in the rect ρ which is the apparent path on the assumption of uniform motion. But the actual rect ρ which is a locus of event-particles is never traversed by the being. These event-particles are the instantaneous facts which pass with the instantaneous moment. What is really traversed are other event-particles which at succeeding instants occupy the same points of space α as those occupied by the event-particles of the rect ρ. For example, we see a stretch of road and a lorry moving along it. The instantaneously seen road is a portion of the rect ρ—of course only an approximation to it. The lorry is the moving object. But the road as seen is never traversed. It is thought of as being traversed because the intrinsic characters of the later events are in general so similar to those of the instantaneous road that we do not trouble to discriminate. But suppose a land mine under the road has been ex-

ploded before the lorry gets there. Then it is fairly obvious that the lorry does not traverse what we saw at first. Suppose the lorry is at rest in space β. Then the straight line r of space α is in the direction of β in space α, and the rect ρ is the representative in the moment M of the line r of space α. The direction of ρ in the instantaneous space of the moment M is the direction of β in M, where M is a moment of time-system α. Again the matrix of the line r of space α will also be the matrix of some line s of space β which will be in the direction of α in space β. Thus if the lorry halts at some point P of space α which lies on the line r, it is now moving along the line s of space β. This is the theory of relative motion; the common matrix is the bond which connects the motion of β in space α with the motions of α in space β.

Motion is essentially a relation between some object of nature and the one timeless space of a time-system. An instantaneous space is static, being related to the static nature at an instant. In perception when we see things moving in an approximation to an instantaneous space, the future lines of motion as immediately perceived are rects which are never traversed. These approximate rects are composed of small events, namely approximate routes and event-particles, which are passed away before the moving objects reach them. Assuming that our forecasts of rectilinear motion are correct, these rects occupy the straight lines in timeless space which are traversed. Thus the rects are symbols in immediate sense-awareness of a future which can only be expressed in terms of timeless space.

We are now in a position to explore the fundamental character of perpendicularity. Consider the two time-systems α and β, each with its own timeless space and its own family of instantaneous moments with their instantaneous spaces. Let M and N be respectively a moment of α and a moment of β. In M there is the direction of β and in N there is the direction of α. But M and N, being moments of different time-systems, intersect in a level. Call this level λ. Then λ is an instantaneous plane in the instantaneous space of M and also in the instantaneous space of N. It is the locus of all the event-particles which lie both in M and in N.

In the instantaneous space of M the level λ is perpendicular to the direction of β in M, and in the instantaneous space of N the level λ is perpendicular to the direction of α in N. This is the fundamental property which forms the definition of perpendicularity. The sym-

metry of perpendicularity is a particular instance of the symmetry of the mutual relations between two time-systems. We shall find in the next lecture that it is from this symmetry that the theory of congruence is deduced.

The theory of perpendicularity in the timeless space of any time-system α follows immediately from this theory of perpendicularity in each of its instantaneous spaces. Let ρ be any rect in the moment M of α and let λ be a level in M which is perpendicular to ρ. The locus of those points of the space of α which intersect M in event-particles on ρ is the straight line r of space α, and the locus of those points of the space of α which intersect M in event-particles on λ is the plane l of space α. Then the plane l is perpendicular to the line r.

In this way we have pointed out unique and definite properties in nature which correspond to perpendicularity. We shall find that this discovery of definite unique properties defining perpendicularity is of critical importance in the theory of congruence which is the topic for the next lecture.

I regret that it has been necessary for me in this lecture to administer such a large dose of four-dimensional geometry. I do not apologise, because I am really not responsible for the fact that nature in its most fundamental aspect is four-dimensional. Things are what they are; and it is useless to disguise the fact that 'what things are' is often very difficult for our intellects to follow. It is a mere evasion of the ultimate problems to shirk such obstacles.

CHAPTER VII *OBJECTS*

The ensuing lecture is concerned with the theory of objects. Objects are elements in nature which do not pass. The awareness of an object as some factor not sharing in the passage of nature is what I call 'recognition.' It is impossible to recognise an event, because an event is essentially distinct from every other event. Recognition is an awareness of sameness. But to call recognition an awareness of sameness implies an intellectual act of comparison accompanied with judgment. I use recognition for the non-intellectual relation of sense-awareness which connects the mind with a factor of nature without passage. On the intellectual side of the mind's experience there are

comparisons of things recognised and consequent judgments of sameness or diversity. Probably 'sense-recognition' would be a better term for what I mean by 'recognition.' I have chosen the simpler term because I think that I shall be able to avoid the use of 'recognition' in any other meaning than that of 'sense-recognition.' I am quite willing to believe that recognition, in my sense of the term, is merely an ideal limit, and that there is in fact no recognition without intellectual accompaniments of comparison and judgment. But recognition is that relation of the mind to nature which provides the material for the intellectual activity.

An object is an ingredient in the character of some event. In fact the character of an event is nothing but the objects which are ingredient in it and the ways in which those objects make their ingression into the event. Thus the theory of objects is the theory of the comparison of events. Events are only comparable because they body forth permanences. We are comparing objects in events whenever we can say, 'There it is again.' Objects are the elements in nature which can 'be again.'

Sometimes permanences can be proved to exist which evade recognition in the sense in which I am using that term. The permanences which evade recognition appear to us as abstract properties either of events or of objects. All the same they are there for recognition although undiscriminated in our sense-awareness. The demarcation of events, the splitting of nature up into parts is effected by the objects which we recognise as their ingredients. The discrimination of nature is the recognition of objects amid passing events. It is a compound of the awareness of the passage of nature, of the consequent partition of nature, and of the definition of certain parts of nature by the modes of the ingression of objects into them.

You may have noticed that I am using the term 'ingression' to denote the general relation of objects to events. The ingression of an object into an event is the way the character of the event shapes itself in virtue of the being of the object. Namely the event is what it is, because the object is what it is; and when I am thinking of this modification of the event by the object, I call the relation between the two 'the ingression of the object into the event.' It is equally true to say that objects are what they are because events are what they are. Nature is such that there can be no events and no objects without the ingression of objects into events. Although there are events

such that the ingredient objects evade our recognition. These are the events in empty space. Such events are only analysed for us by the intellectual probing of science.

Ingression is a relation which has various modes. There are obviously very various kinds of objects; and no one kind of object can have the same sort of relations to events as objects of another kind can have. We shall have to analyse out some of the different modes of ingression which different kinds of objects have into events.

But even if we stick to one and the same kind of objects, an object of that kind has different modes of ingression into different events. Science and philosophy have been apt to entangle themselves in a simple-minded theory that an object is at one place at any definite time, and is in no sense anywhere else. This is in fact the attitude of common-sense thought, though it is not the attitude of language which is naïvely expressing the facts of experience. Every other sentence in a work of literature which is endeavouring truly to interpret the facts of experience expresses differences in surrounding events due to the presence of some object. An object is ingredient throughout its neighbourhood, and its neighbourhood is indefinite. Also the modification of events by ingression is susceptible of quantitative differences. Finally therefore we are driven to admit that each object is in some sense ingredient throughout nature; though its ingression may be quantitatively irrelevant in the expression of our individual experiences.

This admission is not new either in philosophy or science. It is obviously a necessary axiom for those philosophers who insist that reality is a system. In these lectures we are keeping off the profound and vexed question as to what we mean by 'reality.' I am maintaining the humbler thesis that nature is a system. But I suppose that in this case the less follows from the greater, and that I may claim the support of these philosophers. The same doctrine is essentially interwoven in all modern physical speculation. As long ago as 1847 Faraday in a paper in the *Philosophical Magazine* remarked that his theory of tubes of force implies that in a sense an electric charge is everywhere. The modification of the electromagnetic field at every point of space at each instant owing to the past history of each electron is another way of stating the same fact. We can however illustrate the doctrine by the more familiar facts of life without recourse to the abstruse speculations of theoretical physics.

The waves as they roll on to the Cornish coast tell of a gale in mid-Atlantic; and our dinner witnesses to the ingression of the cook into the dining room. It is evident that the ingression of objects into events includes the theory of causation. I prefer to neglect this aspect of ingression, because causation raises the memory of discussions based upon theories of nature which are alien to my own. Also I think that some new light may be thrown on the subject by viewing it in this fresh aspect.

The examples which I have given of the ingression of objects into events remind us that ingression takes a peculiar form in the case of some events; in a sense, it is a more concentrated form. For example, the electron has a certain position in space and a certain shape. Perhaps it is an extremely small sphere in a certain test-tube. The storm is a gale situated in mid-Atlantic with a certain latitude and longitude, and the cook is in the kitchen. I will call this special form of ingression the 'relation of situation'; also, by a double use of the word 'situation,' I will call the event in which an object is situated 'the situation of the object.' Thus a situation is an event which is a relatum in the relation of situation. Now our first impression is that at last we have come to the simple plain fact of where the object really is; and that the vaguer relation which I call ingression should not be muddled up with the relation of situation, as if including it as a particular case. It seems so obvious that any object is in such and such a position, and that it is influencing other events in a totally different sense. Namely, in a sense an object is the character of the event which is its situation, but it only influences the character of other events. Accordingly the relations of situation and influencing are not generally the same sort of relation, and should not be subsumed under the same term 'ingression.' I believe that this notion is a mistake, and that it is impossible to draw a clear distinction between the two relations.

For example, Where was your toothache? You went to a dentist and pointed out the tooth to him. He pronounced it perfectly sound, and cured you by stopping another tooth. Which tooth was the situation of the toothache? Again, a man has an arm amputated, and experiences sensations in the hand which he has lost. The situation of the imaginary hand is in fact merely thin air. You look into a mirror and see a fire. The flames that you see are situated behind the mirror. Again at night you watch the sky; if some of the stars had

vanished from existence hours ago, you would not be any the wiser. Even the situations of the planets differ from those which science would assign to them.

Anyhow you are tempted to exclaim, the cook is in the kitchen. If you mean her mind, I will not argue with you on the point; for I am only talking of nature. Let us think only of her bodily presence. What do you mean by this notion? We confine ourselves to typical manifestations of it. You can see her, touch her, and hear her. But the examples which I have given you show that the notions of the situations of what you see, what you touch, and what you hear are not so sharply separated out as to defy further questioning. You cannot cling to the idea that we have two sets of experiences of nature, one of primary qualities which belong to the objects perceived, and one of secondary qualities which are the products of our mental excitements. All we know of nature is in the same boat, to sink or swim together. The constructions of science are merely expositions of the characters of things perceived. Accordingly to affirm that the cook is a certain dance of molecules and electrons is merely to affirm that the things about her which are perceivable have certain characters. The situations of the perceived manifestations of her bodily presence have only a very general relation to the situations of the molecules, to be determined by discussion of the circumstances of perception.

In discussing the relations of situation in particular and of ingression in general, the first requisite is to note that objects are of radically different types. For each type 'situation' and 'ingression' have their own special meanings which are different from their meanings for other types, though connexions can be pointed out. It is necessary therefore in discussing them to determine what type of objects is under consideration. There are, I think, an indefinite number of types of objects. Happily we need not think of them all. The idea of situation has its peculiar importance in reference to three types of objects which I call sense-objects, perceptual objects and scientific objects. The suitability of these names for the three types is of minor importance, so long as I can succeed in explaining what I mean by them.

These three types form an ascending hierarchy, of which each member presupposes the type below. The base of the hierarchy is formed by the sense-objects. These objects do not presuppose any other type of objects. A sense-object is a factor of nature posited by

sense-awareness which (i), in that it is an object, does not share in the passage of nature and (ii) is not a relation between other factors of nature. It will of course be a relatum in relations which also implicate other factors of nature. But it is always a relatum and never the relation itself. Examples of sense-objects are a particular sort of colour, say Cambridge blue, or a particular sort of sound, or a particular sort of smell, or a particular sort of feeling. I am not talking of a particular patch of blue as seen during a particular second of time at a definite date. Such a patch is an event where Cambridge blue is situated. Similarly I am not talking of any particular concert-room as filled with the note. I mean the note itself and not the patch of volume filled by the sound for a tenth of a second. It is natural for us to think of the note in itself, but in the case of colour we are apt to think of it merely as a property of the patch. No one thinks of the note as a property of the concert-room. We see the blue and we hear the note. Both the blue and the note are immediately posited by the discrimination of sense-awareness which relates the mind to nature. The blue is posited as in nature related to the other factors in nature. In particular it is posited as in the relation of being situated in the event which is its situation.

The difficulties which cluster around the relation of situation arise from the obstinate refusal of philosophers to take seriously the ultimate fact of multiple relations. By a multiple relation I mean a relation which in any concrete instance of its occurrence necessarily involves more than two relata. For example, when John likes Thomas there are only two relata, John and Thomas. But when John gives that book to Thomas there are three relata, John, that book, and Thomas.

Some schools of philosophy, under the influence of the Aristotelian logic and the Aristotelian philosophy, endeavour to get on without admitting any relations at all except that of substance and attribute. Namely all apparent relations are to be resolvable into the concurrent existence of substances with contrasted attributes. It is fairly obvious that the Leibnizian monadology is the necessary outcome of any such philosophy. If you dislike pluralism, there will be only one monad.

Other schools of philosophy admit relations but obstinately refuse to contemplate relations with more than two relata. I do not think that this limitation is based on any set purpose or theory. It merely arises from the fact that more complicated relations are a bother

to people without adequate mathematical training, when they are admitted into the reasoning.

I must repeat that we have nothing to do in these lectures with the ultimate character of reality. It is quite possible that in the true philosophy of reality there are only individual substances with attributes, or that there are only relations with pairs of relata. I do not believe that such is the case; but I am not concerned to argue about it now. Our theme is Nature. So long as we confine ourselves to the factors posited in the sense-awareness of nature, it seems to me that there certainly are instances of multiple relations between these factors, and that the relation of situation for sense-objects is one example of such multiple relations.

Consider a blue coat, a flannel coat of Cambridge blue belonging to some athlete. The coat itself is a perceptual object and its situation is not what I am talking about. We are talking of someone's definite sense-awareness of Cambridge blue as situated in some event of nature. He may be looking at the coat directly. He then sees Cambridge blue as situated practically in the same event as the coat at that instant. It is true that the blue which he sees is due to light which left the coat some inconceivably small fraction of a second before. This difference would be important if he were looking at a star whose colour was Cambridge blue. The star might have ceased to exist days ago, or even years ago. The situation of the blue will not then be very intimately connected with the situation (in another sense of 'situation') of any perceptual object. This disconnexion of the situation of the blue and the situation of some associated perceptual object does not require a star for its exemplification. Any looking glass will suffice. Look at the coat through a looking glass. Then blue is seen as situated behind the mirror. The event which is its situation depends upon the position of the observer.

The sense-awareness of the blue as situated in a certain event which I call the situation, is thus exhibited as the sense-awareness of a relation between the blue, the percipient event of the observer, the situation, and intervening events. All nature is in fact required, though only certain intervening events require their characters to be of certain definite sorts. The ingression of blue into the events of nature is thus exhibited as systematically correlated. The awareness of the observer depends on the position of the percipient event in this systematic correlation. I will use the term 'ingression into nature'

for this systematic correlation of the blue with nature. Thus the ingression of blue into any definite event is a part statement of the fact of the ingression of blue into nature.

In respect to the ingression of blue into nature events may be roughly put into four classes which overlap and are not very clearly separated. These classes are (i) the percipient events, (ii) the situations, (iii) the active conditioning events, (iv) the passive conditioning events. To understand this classification of events in the general fact of the ingression of blue into nature, let us confine attention to one situation for one percipient event and to the consequent *rôles* of the conditioning events for the ingression as thus limited. The percipient event is the relevant bodily state of the observer. The situation is where he sees the blue, say, behind the mirror. The active conditioning events are the events whose characters are particularly relevant for the event (which is the situation) to be the situation for that percipient event, namely the coat, the mirror, and the state of the room as to light and atmosphere. The passive conditioning events are the events of the rest of nature.

In general the situation is an active conditioning event; namely the coat itself, when there is no mirror or other such contrivance to produce abnormal effects. But the example of the mirror shows us that the situation may be one of the passive conditioning events. We are then apt to say that our senses have been cheated, because we demand as a right that the situation should be an active condition in the ingression.

This demand is not so baseless as it may seem when presented as I have put it. All we know of the characters of the events of nature is based on the analysis of the relations of situations to percipient events. If situations were not in general active conditions, this analysis would tell us nothing. Nature would be an unfathomable enigma to us and there could be no science. Accordingly the incipient discontent when a situation is found to be a passive condition is in a sense justifiable; because if that sort of thing went on too often, the *rôle* of the intellect would be ended.

Furthermore the mirror is itself the situation of other sense-objects either for the same observer with the same percipient event, or for other observers with other percipient events. Thus the fact that an event is a situation in the ingression of one set of sense-objects into nature is presumptive evidence that that event is an active con-

dition in the ingression of other sense-objects into nature which may have other situations.

This is a fundamental principle of science which it has derived from common sense.

I now turn to perceptual objects. When we look at the coat, we do not in general say, There is a patch of Cambridge blue; what naturally occurs to us is, There is a coat. Also the judgment that what we have seen is a garment of man's attire is a detail. What we perceive is an object other than a mere sense-object. It is not a mere patch of colour, but something more; and it is that something more which we judge to be a coat. I will use the word 'coat' as the name for that crude object which is more than a patch of colour, and without any allusion to the judgments as to its usefulness as an article of attire either in the past or the future. The coat which is perceived—in this sense of the word 'coat'—is what I call a perceptual object. We have to investigate the general character of these perceptual objects.

It is a law of nature that in general the situation of a sense-object is not only the situation of that sense-object for one definite percipient event, but is the situation of a variety of sense-objects for a variety of percipient events. For example, for any one percipient event, the situation of a sense-object of sight is apt also to be the situations of sense-objects of sight, of touch, of smell, and of sound. Furthermore this concurrence in the situations of sense-objects has led to the body—*i.e.* the percipient event—so adapting itself that the perception of one sense-object in a certain situation leads to a subconscious sense-awareness of other sense-objects in the same situation. This interplay is especially the case between touch and sight. There is a certain correlation between the ingressions of sense-objects of touch and sense-objects of sight into nature, and in a slighter degree between the ingressions of other pairs of sense-objects. I call this sort of correlation the 'conveyance' of one sense-object by another. When you see the blue flannel coat you subconsciously feel yourself wearing it or otherwise touching it. If you are a smoker, you may also subconsciously be aware of the faint aroma of tobacco. The peculiar fact, posited by this sense-awareness of the concurrence of subconscious sense-objects along with one or more dominating sense-objects in the same situation, is the sense-awareness of the perceptual object. The perceptual object is not primarily the issue of

a judgment. It is a factor of nature directly posited in sense-awareness. The element of judgment comes in when we proceed to classify the particular perceptual object. For example, we say, That is flannel, and we think of the properties of flannel and the uses of athletes' coats. But that all takes place after we have got hold of the perceptual object. Anticipatory judgments affect the perceptual object perceived by focussing and diverting attention.

The perceptual object is the outcome of the habit of experience. Anything which conflicts with this habit hinders the sense-awareness of such an object. A sense-object is not the product of the association of intellectual ideas; it is the product of the association of sense-objects in the same situation. This outcome is not intellectual; it is an object of peculiar type with its own particular ingression into nature.

There are two kinds of perceptual objects, namely, 'delusive perceptual objects' and 'physical objects.' The situation of a delusive perceptual object is a passive condition in the ingression of that object into nature. Also the event which is the situation will have the relation of situation to the object only for one particular percipient event. For example, an observer sees the image of the blue coat in a mirror. It is a blue coat that he sees and not a mere patch of colour. This shows that the active conditions for the conveyance of a group of subconscious sense-objects by a dominating sense-object are to be found in the percipient event. Namely we are to look for them in the investigations of medical psychologists. The ingression into nature of the delusive sense-object is conditioned by the adaptation of bodily events to the more normal occurrence, which is the ingression of the physical object.

A perceptual object is a physical object when (i) its situation is an active conditioning event for the ingression of any of its component perpetual objects, and (ii) the same event can be the situation of the perceptual object for an indefinite number of possible percipient events. Physical objects are the ordinary objects which we perceive when our senses are not cheated, such as chairs, tables and trees. In a way physical objects have more insistent perceptive power than sense-objects. Attention to the fact of their occurrence in nature is the first condition for the survival of complex living organisms. The result of this high perceptive power of physical objects is the scholastic philosophy of nature which looks on the sense-objects as

mere attributes of the physical objects. This scholastic point of view is directly contradicted by the wealth of sense-objects which enter into our experience as situated in events without any connexion with physical objects. For example, stray smells, sounds, colours and more subtle nameless sense-objects. There is no perception of physical objects without perception of sense-objects. But the converse does not hold: namely, there is abundant perception of sense-objects unaccompanied by any perception of physical objects. This lack of reciprocity in the relations between sense-objects and physical objects is fatal to the scholastic natural philosophy.

There is a great difference in the *rôles* of the situations of sense-objects and physical objects. The situations of a physical object are conditioned by uniqueness and continuity. The uniqueness is an ideal limit to which we approximate as we proceed in thought along an abstractive set of durations, considering smaller and smaller durations in the approach to the ideal limit of the moment of time. In other words, when the duration is small enough, the situation of the physical object within that duration is practically unique.

The identification of the same physical object as being situated in distinct events in distinct durations is effected by the condition of continuity. This condition of continuity is the condition that a continuity of passage of events, each event being a situation of the object in its corresponding duration, can be found from the earlier to the later of the two given events. So far as the two events are practically adjacent in one specious present, this continuity of passage may be directly perceived. Otherwise it is a matter of judgment and inference.

The situations of a sense-object are not conditioned by any such conditions either of uniqueness or of continuity. In any durations however small a sense-object may have any number of situations separated from each other. Thus two situations of a sense-object, either in the same duration or in different durations, are not necessarily connected by any continuous passage of events which are also situations of that sense-object.

The characters of the conditioning events involved in the ingression of a sense-object into nature can be largely expressed in terms of the physical objects which are situated in those events. In one respect this is also a tautology. For the physical object is nothing else than the habitual concurrence of a certain set of sense-objects in one situation. Accordingly when we know all about the physical

object, we thereby know its component sense-objects. But a physical object is a condition for the occurrence of sense-objects other than those which are its components. For example, the atmosphere causes the events which are its situations to be active conditioning events in the transmission of sound. A mirror which is itself a physical object is an active condition for the situation of a patch of colour behind it, due to the reflection of light in it.

Thus the origin of scientific knowledge is the endeavour to express in terms of physical objects the various *rôles* of events as active conditions in the ingression of sense-objects into nature. It is in the progress of this investigation that scientific objects emerge. They embody those aspects of the character of the situations of the physical objects which are most permanent and are expressible without reference to a multiple relation including a percipient event. Their relations to each other are also characterised by a certain simplicity and uniformity. Finally the characters of the observed physical objects and sense-objects can be expressed in terms of these scientific objects. In fact the whole point of the search for scientific objects is the endeavour to obtain this simple expression of the characters of events. These scientific objects are not themselves merely formulae for calculation; because formulae must refer to things in nature, and the scientific objects are the things in nature to which the formulae refer.

A scientific object such as a definite electron is a systematic correlation of the characters of all events throughout all nature. It is an aspect of the systematic character of nature. The electron is not merely where its charge is. The charge is the quantitative character of certain events due to the ingression of the electron into nature. The electron is its whole field of force. Namely the electron is the systematic way in which all events are modified as the expression of its ingression. The situation of an electron in any small duration may be defined as that event which has the quantitative character which is the charge of the electron. We may if we please term the mere charge the electron. But then another name is required for the scientific object which is the full entity which concerns science, and which I have called the electron.

According to this conception of scientific objects, the rival theories of action at a distance and action by transmission through a medium are both incomplete expressions of the true process of nature. The stream of events which form the continuous series of situations of

the electron is entirely self-determined, both as regards having the intrinsic character of being the series of situations of that electron and as regards the time-systems with which its various members are cogredient, and the flux of their positions in their corresponding durations. This is the foundation of the denial of action at a distance; namely the progress of the stream of the situations of a scientific object can be determined by an analysis of the stream itself.

On the other hand the ingression of every electron into nature modifies to some extent the character of every event. Thus the character of the stream of events which we are considering bears marks of the existence of every other electron throughout the universe. If we like to think of the electrons as being merely what I call their charges, then the charges act at a distance. But this action consists in the modification of the situation of the other electron under consideration. This conception of a charge acting at a distance is a wholly artificial one. The conception which most fully expresses the character of nature is that of each event as modified by the ingression of each electron into nature. The ether is the expression of this systematic modification of events throughout space and throughout time. The best expression of the character of this modification is for physicists to find out. My theory has nothing to do with that and is ready to accept any outcome of physical research.

The connexion of objects with space requires elucidation. Objects are situated in events. The relation of situation is a different relation for each type of object, and in the case of sense-objects it cannot be expressed as a two-termed relation. It would perhaps be better to use a different word for these different types of the relation of situation. It has not however been necessary to do so for our purposes in these lectures. It must be understood however that, when situation is spoken of, some one definite type is under discussion, and it may happen that the argument may not apply to situation of another type. In all cases however I use situation to express a relation between objects and events and not between objects and abstractive elements. There is a derivative relation between objects and spatial elements which I call the relation of location; and when this relation holds, I say that the object is located in the abstractive element. In this sense, an object may be located in a moment of time, in a volume of space, an area, a line, or a point. There will be a peculiar type of location corresponding to each type of situation;

and location is in each case derivative from the corresponding relation of situation in a way which I will proceed to explain.

Also location in the timeless space of some time-system is a relation derivative from location in instantaneous spaces of the same time-system. Accordingly location in an instantaneous space is the primary idea which we have to explain. Great confusion has been occasioned in natural philosophy by the neglect to distinguish between the different types of objects, the different types of situation, the different types of location, and the difference between location and situation. It is impossible to reason accurately in the vague concerning objects and their positions without keeping these distinctions in view. An object is located in an abstractive element, when an abstractive set belonging to that element can be found such that each event belonging to that set is a situation of the object. It will be remembered that an abstractive element is a certain group of abstractive sets, and that each abstractive set is a set of events. This definition defines the location of an element in any type of abstractive element. In this sense we can talk of the existence of an object at an instant, meaning thereby its location in some definite moment. It may also be located in some spatial element of the instantaneous space of that moment.

A quantity can be said to be located in an abstractive element when an abstractive set belonging to the element can be found such that the quantitative expressions of the corresponding characters of its events converge to the measure of the given quantity as a limit when we pass along the abstractive set towards its converging end.

By these definitions location in elements of instantaneous spaces is defined. These elements occupy corresponding elements of timeless spaces. An object located in an element of an instantaneous space will also be said to be located at that moment in the timeless element of the timeless space which is occupied by that instantaneous element.

It is not every object which can be located in a moment. An object which can be located in every moment of some duration will be called a 'uniform' object throughout that duration. Ordinary physical objects appear to us to be uniform objects, and we habitually assume that scientific objects such as electrons are uniform. But some sense-objects certainly are not uniform. A tune is an example of a non-uniform object. We have perceived it as a whole in a certain dura-

tion; but the tune as a tune is not at any moment of that duration though one of the individual notes may be located there.

It is possible therefore that for the existence of certain sorts of objects, *e.g.* electrons, minimum quanta of time are requisite. Some such postulate is apparently indicated by the modern quantum theory and it is perfectly consistent with the doctrine of objects maintained in these lectures.

Also the instance of the distinction between the electron as the mere quantitative electric charge of its situation and the electron as standing for the ingression of an object throughout nature illustrates the indefinite number of types of objects which exist in nature. We can intellectually distinguish even subtler and subtler types of objects. Here I reckon subtlety as meaning seclusion from the immediate apprehension of sense-awareness. Evolution in the complexity of life means an increase in the types of objects directly sensed. Delicacy of sense-apprehension means perceptions of objects as distinct entities which are mere subtle ideas to cruder sensibilities. The phrasing of music is a mere abstract subtlety to the unmusical; it is a direct sense-apprehension to the initiated. For example, if we could imagine some lowly type of organic being thinking and aware of our thoughts, it would wonder at the abstract subtleties in which we indulge as we think of stones and bricks and drops of water and plants. It only knows of vague undifferentiated feelings in nature. It would consider us as given over to the play of excessively abstract intellects. But then if it could think, it would anticipate; and if it anticipated, it would soon perceive for itself.

In these lectures we have been scrutinising the foundations of natural philosophy. We are stopping at the very point where a boundless ocean of enquiries opens out for our questioning.

I agree that the view of Nature which I have maintained in these lectures is not a simple one. Nature appears as a complex system whose factors are dimly discerned by us. But, as I ask you, Is not this the very truth? Should we not distrust the jaunty assurance with which every age prides itself that it at last has hit upon the ultimate concepts in which all that happens can be formulated? The aim of science is to seek the simplest explanations of complex facts. We are apt to fall into the error of thinking that the facts are simple because simplicity is the goal of our quest. The guiding motto in the life of every natural philosopher should be, Seek simplicity and distrust it.

The Principle of Relativity with Applications to Physical Science

Preface		297
Chapter I	Prefatory Explanations	297
Chapter II	The Relatedness of Nature	305
Chapter III	Equality	322
Chapter IV	Some Principles of Physical Science	337

PREFACE

The present work is an exposition of an alternative rendering of the theory of relativity. It takes its rise from that 'awakening from dogmatic slumber'—to use Kant's phrase—which we owe to Einstein and Minkowski. But it is not an attempt to expound either Einstein's earlier or his later theory. The metrical formulae finally arrived at are those of the earlier theory, but the meanings ascribed to the algebraic symbols are entirely different. As the result of a consideration of the character of our knowledge in general, and of our knowledge of nature in particular, undertaken in Part I of this book and in my two previous works* on this subject, I deduce that our experience requires and exhibits a basis of uniformity, and that in the case of nature this basis exhibits itself as the uniformity of spatio-temporal relations. This conclusion entirely cuts away the casual heterogeneity of these relations which is the essential of Einstein's later theory. It is this uniformity which is essential to my outlook, and not the Euclidean geometry which I adopt as lending itself to the simplest exposition of the facts of nature. I should be very willing to believe that each permanent space is either uniformly elliptic or uniformly hyperbolic, if any observations are more simply explained by such a hypothesis.

It is inherent in my theory to maintain the old division between physics and geometry. Physics is the science of the contingent relations of nature and geometry expresses its uniform relatedness.

CHAPTER I *PREFATORY EXPLANATIONS*

The doctrine of relativity affects every branch of natural science, not excluding the biological sciences. In general, however, this impact of the new doctrine on the older sciences lies in the future and will disclose

* *The Principles of Natural Knowledge*, and *The Concept of Nature*, both Cambridge Univ. Press.

itself in ways not yet apparent. Relativity, in the form of novel formulae relating time and space, first developed in connection with electromagnetism, including light phenomena. Einstein then proceeded to show its bearing on the formulae for gravitation. It so happens therefore that owing to the circumstances of its origin a very general doctrine is linked with two special applications.

In this procedure science is evolving according to its usual mode. In that atmosphere of thought doctrines are valued for their utility as instruments of research. Only one question is asked: Has the doctrine a precise application to a variety of particular circumstances so as to determine the exact phenomena which should be then observed? In the comparative absence of these applications beauty, generality, or even truth, will not save a doctrine from neglect in scientific thought. With them, it will be absorbed.

Accordingly a new scientific outlook clings to those fields where its first applications are to be found. They are its title deeds for consideration. But in testing its truth, if the theory have the width and depth which marks a fundamental reorganisation, we cannot wisely confine ourselves solely to the consideration of a few happy applications. The history of science is strewn with the happy applications of discarded theories. There are two gauges through which every theory must pass. There is the broad gauge which tests its consonance with the general character of our direct experience, and there is the narrow gauge which is that mentioned above as being the habitual working gauge of science. These reflections have been suggested by the advice received from two distinguished persons to whom at different times I had explained the scheme of this book. The philosopher advised me to omit the mathematics, and the mathematician urged the cutting out of the philosophy. At the moment I was persuaded: it certainly is a nuisance for philosophers to be worried with applied mathematics, and for mathematicians to be saddled with philosophy. But further reflection has made me retain my original plan. The difficulty is inherent in the subject matter.

To expect to reorganise our ideas of Time, Space, and Measurement without some discussion which must be ranked as philosophical is to neglect the teaching of history and the inherent probabilities of the subject. On the other hand no reorganisation of these ideas can command confidence unless it supplies science with added power in the analysis of phenomena. The evidence is two-fold, and is fatally weakened if the two parts are disjoined.

At the same time it is well to understand the limitations to the meaning of 'philosophy' in this connection. It has nothing to do with ethics or theology or the theory of aesthetics. It is solely engaged in determining the most general conceptions which apply to things observed by the senses. Accordingly it is not even metaphysics: it should be called panphysics. Its task is to formulate those principles of science which are employed equally in every branch of natural science. Sir J. J. Thomson, reviewing in *Nature** Poynting's *Collected Papers*, has quoted a statement taken from one of Poynting's addresses:

'I have no doubt whatever that our ultimate aim must be to describe the sensible in terms of the sensible.'

Adherence to this aphorism, sanctioned by the authority of two great English physicists, is the keynote of everything in the following chapters. The philosophy of science is the endeavour to formulate the most general characters of things observed. These sought-for characters are to be no fancy characters of a fairy tale enacted behind the scenes. They must be observed characters of things observed. Nature is what is observed, and the ether is an observed character of things observed. Thus the philosophy of science only differs from any of the special natural sciences by the fact that it is natural science at the stage before it is convenient to split it up into its various branches. This philosophy exists because there is something to be said before we commence the process of differentiation. It is true that in human thought the particular precedes the general. Accordingly the philosophy will not advance until the branches of science have made independent progress. Philosophy then appears as a criticism and a corrective, and—what is now to the purpose—as an additional source of evidence in times of fundamental reorganisation.

This assignment of the rôle of philosophy is borne out by history. It is not true that science has advanced in disregard of any general discussion of the character of the universe. The scientists of the Renaissance and their immediate successors of the seventeenth century, to whom we owe our traditional concepts, inherited from Plato, Aristotle and the medieval scholastics. It is true that the New Learning reacted violently against the schoolmen who were their immediate predecessors; but, like the Israelites when they fled from Egypt, they borrowed their valuables—and in this case the valuables were certain root-presupposi-

* Dec. 30, 1920.

tions respecting space, time, matter, predicate and subject, and logic in general. It is legitimate (as a practical counsel in the management of a short life) to abstain from the criticism of scientific foundations so long as the superstructure 'works.' But to neglect philosophy when engaged in the re-formation of ideas is to assume the absolute correctness of the chance philosophic prejudices imbibed from a nurse or a schoolmaster or current modes of expression. It is to enact the part of those who thank Providence that they have been saved from the perplexities of religious enquiry by the happiness of birth in the true faith. The truth is that your available concepts depend upon your philosophy. An examination of the writings of John Stuart Mill and his immediate successors on the procedure of science—writings of the highest excellence within their limitations—will show that they are exclusively considering the procedure of science in the framing of laws with the employment of given concepts. If this limitation be admitted, the conclusion at once follows that philosophy is useless in the progress of science. But when once you tamper with your basic concepts, philosophy is merely the marshalling of one main source of evidence, and cannot be neglected.

But when all has been said respecting the importance of philosophy for the discovery of scientific truth, the narrow-gauged pragmatic test will remain the final arbiter. Accordingly I now proceed to a summary account of the general doctrine either implicit or explicit in the following pages or in my two previous books* on this subject, and to detail the facts of experience which receive their explanation from it or should be observed if it be true.

A relativistic view of time is adopted so that an instantaneous moment of time is nothing else than an instantaneous and simultaneous spread of the events of the universe. But in the concept of instantaneousness the concept of the passage of time has been lost. Events essentially involve this passage. Accordingly the self-contradictory idea of an instantaneous event has to be replaced by that of an instantaneous configuration of the universe. But what is directly observed is an event. Thus a duration, which is a slab of time with temporal thickness, is the final fact of observation from which moments and configurations are deduced as a limit which is a logical ideal of the exact precision inherent in nature. This process of deducing limits is considered in detail in my

* *The Principles of Natural Knowledge*, and *The Concept of Nature*, both Cambridge Univ. Press.

two previous books under the title Extensive Abstraction. But it is an essential assumption that a concrete fact of nature always includes temporal passage.

A moment expresses the spread of nature as a configuration in an instantaneous three dimensional space. The flow of time means the succession of moments, and this succession includes the whole of nature. Rest and motion are direct facts of observation concerning the relation of objects to the durations whose limits are the moments of this flow of time. By means of rest a permanent point is defined which is merely a track of event-particles with one event-particle in every moment.

Refined observation (in the form of the Michelson-Morley experiment and allied experiments) shows that there are alternative flows of time—or time-systems, as they will be called,—and that the time-system actually observed is that one for which (roughly speaking) our body is at rest. Accordingly in different circumstances of motion, space and time mean different things, the moments of one time-system are different from the moments of another time-system, the permanent points of one time-system are different from those of another time-system, so that the permanent space of one time-system is distinct from the permanent space of another time-system.

The properties of time and space express the basis of uniformity in nature which is essential for our knowledge of nature as a coherent system. The physical field expresses the unessential uniformities regulating the contingency of appearance. In a fuller consideration of experience they may exhibit themselves as essential; but if we limit ourselves to nature there is no essential reason for the particular nexus of appearance.

Thus times and spaces are uniform.

Position in space is merely the expression of diversity of relations to alternative time-systems. Order in space is merely the reflection into the space of one time-system of the time-orders of alternative time-systems.

A plane in space expresses the quality of the locus of intersection of a moment of the time-system in question (call it 'time-system *A*') with a moment of another time-system (time-system *B*).

The parallelism of planes in the space of time-system *A* means that these planes result from the intersections of moments of *A* with moments of one other time-system *B*.

A straight line in the space of time-system *A* perpendicular to the planes due to time-system *B* is the track in the space of time-system *A* of a body at rest in the space of time-system *B*.

Thus the uniform Euclidean geometry of spaces, planeness, parallelism, and perpendicularity are merely expressive of the relations to each other of alternative time-systems.

The tracks which are the permanent points of the same time-system are also reckoned as parallels.

Congruence—and thence, spatial measurement—is defined in terms of the properties of parallelograms and the symmetry of perpendicularity.

Accordingly, position, planes, straight lines, parallelism, perpendicularity, and congruence are expressive of the mutual relations of alternative time-systems.

The symmetrical properties of relative velocity are shown (in *The Principles of Natural Knowledge*) to issue in a critical velocity *c*, which thus is defined without reference to the velocity of light. However experiment shows that for our purposes it must be a near approach to that velocity. The final result is the geometry and kinematic which are explained in Chapter IV of the present volume.

A physical object, such as a mass-particle or an electron, expresses the character of the future so far as it is determined by the happenings of the present. The exact meaning of an object as an entity implicated in events is explained. The track of an object amid events is determined by the 'stationary' property of the impetus realised by the pervasion of the track by the object. This impetus depends partly on the intrinsic character of the object—e.g. its mass or its electric charge—and partly on the intrinsic potential impetus of the track itself. This potential impetus arises from the physical character of the events of the region due to the presence of other objects in the past. This physical character is partly gravitational and partly electrical.

This dependence of physical character on antecedent objects is directly expressed by the formula here adopted for the gravitational law. This law also gives the most direct expression to the principle that the flux of time is essential to the concrete reality of nature, so that a loss of time-flux means a transference to a higher abstraction. It gives this expression by conceiving the attracting body as pervading an element of its track and not as at an event-particle. This law gives the Einstein expression for the revolution of the perihelion of Mercury.

The electromagnetic equations adopted are Maxwell's equations

modified by the gravitational tensor components in the well-known way. Light is given no privileged position, and all deductions concerning light follow directly from treating it as consisting of short waves of electromagnetic disturbance. In this way Einstein's assumption that a ray of light follows the path

$$dJ^2 = 0$$

[i.e. in Einstein's notation

$$ds^2 = 0]$$

can be proved as an approximation due to the shortness of the waves.

The bending of the light rays in a gravitational field then follows.

With regard to the shift of spectral lines, there are three effects to be considered: (i) Einstein's predicted shift due to the gravitational potential, (ii) the limb effect which has been observed in the case of light from the sun, (iii) the doubling or trebling of spectral lines observed in the spectra due to some nebulae. Neither of the effects (ii) or (iii) has hitherto been explained.

As to (i) this is traced to the combination of two causes, one being the change in the apparent mass due to the gravitational potential and the other being the change in the electric cohesive forces of the molecule due to the gravitational field. The total result is that the period of vibration is changed from T to $T + \delta T$, where

$$\frac{\delta T}{T} = \frac{13}{6}\frac{\psi_4}{c^2},$$

ψ_4 being the gravitational potential. Einstein's result is ψ_4/c^2, so that the two formulae are practically identical for observational purposes.

With regard to effects (ii) and (iii) reasons are given for believing that the molecules will separate into three groups sending a distant observer light of changing relative intensities as we pass from the centre of the disc of the emitting body (sun or nebulae) to the edge. One group has the above-mentioned shift, another has the shift

$$\frac{\delta T}{T} = \frac{5 - 2\eta}{2c^2}\psi_4$$

(where η is probably about 1/10, but may be nearly 1/5), and the third group has the shift

$$\frac{\delta T}{T} = \frac{3 + \eta}{2c^2}\psi_4.$$

Under circumstances such that all or two of the groups send separately observable light, the trebling or doubling effects are explained to the extent of demonstrating the existence of causes for the multiplication of lines, other than those due to the motions of the matter of the nebulae. Under other circumstances (e.g. light from the sun's disc) in which the influence of the grouping is effective but not separately observable the shift approximates to

$$\frac{\delta T}{T} = \frac{1}{c^2}\psi_4\{2 + \tfrac{1}{2}\eta + \tfrac{1}{4}(1 - 3\eta)\sin^2\beta_1\},$$

where β_1 varies from zero at the centre of the disc of the sun to $\pi/2$ at its edge. But there will be various intermediate circumstances between these extreme assumptions as to the observability of the grouping effect.

Finally in a steady electromagnetic field the electromagnetic equations predict two novel magnetic forces due to the gravitational field. These forces are excessively small: (i) A steady electric force at a point on the earth's surface (F in electrostatic units) should be accompanied by the horizontal magnetic force

$$1{\cdot}2 \times 10^{-9} \times F \sin \alpha \text{ (gausses)}$$

perpendicular to its direction and to the vertical, where α is the angle between these directions.

(ii) A steady current (I in electromagnetic measure) in a straight wire making an angle β with the vertical should produce at a point distant R from the wire the parallel magnetic force (i.e. in a direction parallel to the wire),

$$\frac{1}{2} \times 10^{-9} \times \cos\phi \sin 2\beta \times \frac{2I}{R} \text{ (gausses)},$$

where ϕ is the angle between the vertical plane through the wire and the plane through the wire and the point. The temperature of an attracting body should augment its gravitational field by an amount which is probably outside the limits of our observational powers.

CHAPTER II *THE RELATEDNESS OF NATURE*

"Threads and floating wisps
Of being, . . ."

CLEMENCE DANE'S *Will Shakespeare*, Act I.

You have conferred upon me the honour of becoming the first recipient of the 'James-Scott Prize,' and have at the same time assigned to me the duty of delivering a lecture upon the subject which this prize is designed to foster. In choosing the topic of a lecture which is to be the first of a series upon the philosophy of science, it seems suitable to explore the broadest possible aspect of the subject. Accordingly I propose to address you upon Relatedness and, in particular, upon the Relatedness of Nature. I feel some natural diffidence in speaking upon this theme in the capital of British metaphysics, haunted by the shade of Hume. This great thinker made short work of the theory of the relatedness of nature as it existed in the current philosophy of his time. It is hardly too much to say that the course of subsequent philosophy, including even Hume's own later writings and the British Empirical School, but still more in the stream which descends through Kant, Hegel and Caird, has been an endeavour to restore some theory of relatedness to replace the one demolished by Hume's youthful scepticism. If you once conceive fundamental fact as a multiplicity of subjects qualified by predicates, you must fail to give a coherent account of experience. The disjunction of subjects is the presupposition from which you start, and you can only account for conjunctive relations by some fallacious sleight of hand, such as Leibniz's metaphor of his monads engaged in mirroring. The alternative philosophic position must commence with denouncing the whole idea of 'subject qualified by predicate' as a trap set for philosophers by the syntax of language. The conclusion which I shall wish to enforce is that we can discern in nature a ground of uniformity, of which the more far-reaching example is the uniformity of space-time and the more limited example is what is usually known under the title, The Uniformity of Nature. My arguments must be based upon considerations of the utmost generality untouched by the peculiar features of any particular natural science. It is therefore inevitable that at the

beginning my exposition will suffer from the vagueness which clings to generality.

Fact is a relationship of factors. Every factor of fact essentially refers to its relationships within fact. Apart from this reference it is not itself. Thus every factor of fact has fact for its background, and refers to fact in a way peculiar to itself.

I shall use the term 'awareness' for consciousness of factors within fact. A converse mode of statement is that awareness is consciousness of fact as involving factors. Awareness is itself a factor within fact.

I shall use the term 'cogitation' for consciousness of factors prescinded from their background of fact. It is the consciousness of the individuality of factors, in that each factor is itself and not another. A factor cogitated upon as individual will be called an 'entity.' The essence of cogitation is consciousness of diversity. The prescinding from the background of fact consists in limiting consciousness to awareness of the contrast of factors. Cogitation thus presupposes awareness and is limited by the limitations of awareness. It is the refinement of awareness, and the unity of consciousness lies in this dependence of cogitation upon awareness. Thus awareness is crude consciousness and cogitation is refined consciousness. For awareness all relations between factors are internal and for cogitation all relations between entities are external.

Fact in its totality is not an entity for cogitation, since it has no individuality by its reference to anything other than itself. It is not a relatum in the relationship of contrast. I might have used the term 'totality' instead of 'fact'; but 'fact' is shorter and gives rise to the convenient term 'factor.' Fact enters consciousness in a way peculiar to itself. It is not the sum of factors; it is rather the concreteness (or, embeddedness) of factors, and the concreteness of an inexhaustible relatedness among inexhaustible relata. If for one moment I may use the inadmissible word 'Factuality,' it is in some ways better either than 'fact' or 'totality' for the expression of my meaning. For 'fact' suggests one fact among others. This is not what I mean, and is a subordinate meaning which I express by 'factor.' Also 'totality' suggests a definite aggregate which is all that there is, and which can be constructed as the sum of all subordinate aggregates. I deny this view of factuality. For example, in the very conception of the addition of subordinate aggregates, the concept of the addition is omitted although this concept is itself a factor of factuality. Thus inexhaustibleness is the prime character of factuality as disclosed in awareness; that is to say, factuality (even as in individual

awareness) cannot be exhausted by any definite class of factors. After this explanation I will now relapse into the use of 'fact' in the sense of 'factuality.'

The finiteness of consciousness, the factorisation of fact, the individualisation of entities in cogitation, and the opposition of abstract to concrete are all exhibitions of the same truth of the existence of limitation within fact. The abstract is a limitation within the concrete, the entity is a limitation within totality, the factor is a limitation within fact, and consciousness by its reference to its own standpoint within fact limits fact to fact as apprehended in consciousness. The treatment of the whole theory of limitation has suffered by the introduction of metaphors derived from a highly particular form of it, namely, derived from the analogy between extended things, such as that of whole to part and that of things mutually external to each other.

I use the term 'limitation' for the most general conception of finitude. In a somewhat more restricted sense Bergson uses the very convenient term 'canalisation.' This Bergsonian term is a useful one to keep in mind as a corrective to the misleading associations of the terms 'external' and 'internal,' or of the terms 'whole' and 'part.' It adds also a content to the negative term 'limitation.' Thus a factor is a limitation of fact in the sense that a factor refers to fact canalised into a system of relata to itself, i.e. to the factor in question. The mere negative limitation, or finitude, involved in a factor is exhibited in cogitation, wherein the factor degenerates into an entity and the canalisation degenerates into a bundle of external relations.

Thus also finite consciousness is a limitation of fact, in the sense that it is a factor canalising fact in ways peculiar to itself. We must get rid of the notion of consciousness as a little box with some things inside it. A better metaphor is that of the contact of consciousness with other factors, which is practically Hume's metaphor 'impression.' But this metaphor erroneously presupposes that fact as disclosed in awareness can be constructed as an entity formed by the sum of the impressions of isolated factors.

Again cogitation is a further limitation of fact in that it is a canalisation of consciousness so as to divest it of the crudeness of awareness. This illustrates that in limitation there is a gain in clarity, or definition, or intensity, but a loss of content.

For example, the factor red refers to fact as canalised by relationships of other factors to red, and the entity red is the factor red in its

capacity as a relatum in the relationship of contrast, whereby it is contrasted with green or with sound or with the moon or with the multiplication table. Thus the factor red, essentially for its being, occasions the exhibition of a special aspect of fact, and the entity red is a further limitation of this aspect. Similarly the number three is nothing else than the aspect of fact as factors grouped in triplets. And the Tower of London is a particular aspect of the Universe in its relation to the banks of the Thames. Thus an entity is an abstraction from the concrete, which in its fullest sense means totality.

The point of this doctrine on which I want to insist is that any factor, by virtue of its status as a limitation within totality, necessarily refers to factors of totality other than itself. It is therefore impossible to find anything finite, that is to say, any entity for cogitation, which does not in its apprehension by consciousness disclose relationships to other entities, and thereby disclose some systematic structure of factors within fact. I call this quality of finitude, the significance of factors. This doctrine of significance necessitates that we admit that awareness requires a dual cognisance of entities. There can be awareness of a factor as signifying, and awareness of a factor as signified. In a sense this may be represented as an active or a passive cognisance of the entity. The entity is either cognised for its own sake, that is to say, actively, or it is cognised for the sake of other entities, that is to say, passively. If an entity is cognised actively, it is cognised for the sake of what it is in itself, for the sake of what it can make of the universe. I will call this sort of awareness of a factor, cognisance by adjective; since it is the character of the factor in itself which is then dominant in consciousness. Although in cognisance by adjective an entity is apprehended as a definite character in its relations to other entities, yet in a sense this type of cognisance marks a breakdown in relatedness. For the general relatedness of the character to other factors merely marks the fullness of its content, so that in effect the character is cognised for what it is in itself. Relationships to other factors occur in such cognisance only because the character is not itself apart from that ordering of fact.

When an entity is cognised passively, we are aware of it for the sake of some other factor. We are conscious passively of factor A, because factor B of which we are actively aware would not be what it is apart from its relatedness to A. Thus the individual character of A is in the

background, and *A* becomes a vague something which is an element in a complex of systematic relatedness. The very nature of the relatedness may impose on *A* some character. But the character is gained through the relatedness and not the relatedness through the character. Accordingly *A* gains in consciousness the very minimum foothold for the relationship of contrast, and is thus the most shadowy of entities. I will call this sort of awareness of a factor, cognisance by relatedness. For example the knowledge of events inside another room is to be gained by their spatial and other relationships to events of which we have cognisance by adjective.

Thus cognisance of one factor by relatedness presupposes cognisance of other factors by adjective; and conversely, cognisance of one factor by adjective presupposes cognisance of other factors by relatedness.

It is possible to be aware of a factor both in cognisance by adjective and cognisance by relatedness. This will be termed 'full awareness' of the factor and is the usual form of awareness of factors within the area of clear apprehension when intrinsic characters and mutual relations are jointly apparent. 'Perception' will be the name given to the consciousness of a factor when to full awareness cogitation of it as an entity is also superadded.

But cogitation does not necessarily presuppose full awareness. For the contrast involved in cogitation may simply fall on the quality of the individualities of the factors, as when green as such is contrasted with red as such. In such a case merely awareness by adjective is presupposed. But the contrast may also fall on the specific relationships of each of the two factors to other factors, as when we contrast an event in the interior of the moon with another event in the interior of the earth. The spatio-temporal relationships of the two events are then contrasted; and it is from contrasts of this type that the two events gain their definite individuality as entities.

At this point in the discussion I will confine the scope of the remainder of my lecture strictly to the consideration of the relatedness of nature. This requires us to recognise another limitation within awareness which cuts across those already mentioned. I mean the limitation of awareness to sense-awareness. Nature is the system of factors apprehended in sense-awareness. But sense-awareness can only be defined negatively by enumerating what it is not.

Divest consciousness of its ideality, such as its logical, emotional, aesthetic and moral apprehensions, and what is left is sense-awareness. Thus sense-awareness is consciousness minus its apprehensions of ideality. It is not asserted that there is consciousness in fact divested of ideality, but that awareness of ideality and sense-awareness are two factors discernible in consciousness. The question as to whether either the one or the other, or both jointly may not be a factor necessary for consciousness is beyond the scope of the present discussion. The finiteness of individual consciousness means ignorance of what is there for knowledge. There is limitation of factors cognised by adjective, and equally there is limitation of factors cognised by relatedness. So it is perfectly possible to hold, as I do hold, that nature is significant of ideality, without being at all certain that there may not be some awareness of nature without awareness of ideality as signified by nature. It would have, I think, to be a feeble awareness. Perhaps it is more likely that ideality and nature are dim together in dim consciousness. It is unnecessary for us to endeavour to solve these doubts. My essential premise is that we are conscious of a certain definite assemblage of factors within fact and that this assemblage is what I call nature. Also I entirely agree that the factors of nature are also significant of factors which are not included in nature. But I propose to ignore this admitted preternatural significance of nature, and to analyse the general character of the relatedness of natural entities between themselves.

Nature usually presents itself to our imagination as being composed of all those entities which are to be found somewhere at some time. Sabre-toothed tigers are part of nature because we believe that somewhere and at some time sabre-toothed tigers were prowling. Thus an essential significance of a factor of nature is its reference to something that happened in time and space. I give the name 'event' to a spatio-temporal happening. An event does not in any way imply rapid change; the endurance of a block of marble is an event. Nature presents itself to us as essentially a becoming, and any limited portion of nature which preserves most completely such concreteness as attaches to nature itself is also a becoming and is what I call an event. By this I do not mean a bare portion of space-time. Such a concept is a further abstraction. I mean a part of the becomingness of nature, coloured with all the hues of its content.

Thus nature is a becomingness of events which are mutually significant so as to form a systematic structure. We express the character of the

systematic structure of events in terms of space and time. Thus space and time are abstractions from this structure.

Let us now examine more particularly the significance of events in so far as it falls within nature. In this way we are treating nature as a closed system, and this I believe is the standpoint of natural science in the strict sense of the term.

But before embarking on the details of this investigation I should like to draw your attention to an objection, and a very serious objection, which is urged by opponents of the whole philosophic standpoint which I have been developing. You admit, it is said, that a factor is not itself apart from its relations to other factors. Accordingly to express any truth about one entity you must take into account its relations to all entities. But this is beyond you. Hence, since unfortunately a proposition must be either right or wrong or else unmeaning and a mere verbal jangle, the attainment of truth in any finite form is also beyond you.

Now I do not think that it is any answer to this argument to say that our propositions are only a little wrong, any more than it is a consolation to his friends to say that a man is only a little dead. The gist of the argument is that on our theory any ignorance is blank ignorance, because knowledge of any factor requires no ignorance. A philosophy of relatedness which cannot answer this argument must collapse, since we have got to admit ignorance.

Obviously if this argument is to be answered, I must guard and qualify some of the statements which have been made in the earlier portion of this lecture. I have put off the job until now, partly for the sake of simplicity, not to say too much at once, and also partly because the line of argument is most clearly illustrated in the case of nature, and indeed the application to nature is the only one in which for the purposes of this lecture we are interested. So I have waited until my discourse had led me to the introduction of nature.

The answer can only take one road, we must distinguish between the essential and the contingent relationships of a factor. The essential relationships of a factor are those relationships which are inherent in the peculiar individuality of the factor, so that apart from them the factor is not the special exhibition of finitude within fact which it is. They are the relationships which place the factor as an entity amid a definite system of entities. The significance of a factor is solely concerned with its essential relationships. The contingent relationships of a factor are those relationships between that factor and other factors

which might be otherwise without change of the particular individuality of the factor. In other words, the factor would be what it is even if its contingent relationships were otherwise.

Thus awareness of a factor must include awareness of its essential relationships, and is compatible with ignorance of its contingent relationships.

It is evident that essential and contingent relationships correspond closely to internal and external relations. I hesitate to say how closely, since a different philosophic outlook radically affects all meanings.

We still have to explain how awareness of a factor can exclude ignorance of the relationships involved in its significance. For, on the face of it, this doctrine means that to perceive factor *A* we require also to perceive factors *B*, *C*, *D*, etc., which *A* signifies. In view of the possibilities of ignorance, such a doctrine appears to be extremely doubtful. This objection ignores the analysis of awareness into cognisance by adjective and cognisance by relatedness. In order to perceive *A* we do not require to be conscious of *B*, *C*, *D*, with cognisance by adjective. We only require cognisance by relatedness. In other words we must be conscious of *B*, *C*, *D*, . . . as entities requisite for that relatedness to *A*, which is involved in *A*'s significance. But even this explanation asks for too much. It suggests that we must be conscious of *B*, *C*, *D*, . . . as a definite numerical aggregate of entities signified by *A*. Now it is evident that no factor *A* makes us conscious of the individual entities of such an aggregate. Some necessary qualification of the doctrine of significance has been omitted. The missing principle is that any factor *A* has to be uniformly significant. Every entity involves that fact shall be patient of it. The patience of fact for *A* is the converse side of the significance of *A* within fact. This involves a canalisation within fact; and this means a systematic aggregate of factors each with the uniform impress of the patience of fact for *A*. *A* can be, because they are. Each such factor individually expresses the patience of fact for *A*.

Thus the knowledge required by the significance of *A* is simply this. In order to know *A* we must know how other factors express the patience of fact for *A*. We need not be aware of these other factors individually, but the awareness of *A* does require an awareness of their defining character. There is no such entity as mere *A* in isolation. *A* requires something other than itself, namely, factors expressing the patience of fact in respect to factor *A*.

Let us now apply to nature this doctrine of uniform significance.

We commence by taking the case of the colour green. When we perceive green, it is not green in isolation, it is green somewhere at some time. The green may or may not have the relationship to some other object, such as a blade of grass. Such a relation would be contingent. But it is essential that we see it somewhere in space related to our eyes at a certain epoch of our bodily life. The detailed relationships of green to our bodily life and to the situations in which it is apparent to our vision are complex and variable and partake of the contingence which enables us to remain ignorant of them. But there can be no knowledge of green without apprehension of times and places. Green presupposes here and there, and now and then. In other words, green presupposes the passage of nature in the form of a structure of events. It may be merely green associated vaguely with the head, green all about me; but green is not green apart from its signification of events with structural coherence, which are factors expressing the patience of fact for green.

A blade of grass is an object of another type which signifies nature as a passage of events. In this respect it only differs from green in so far as its contingent relations to some definite events are perhaps sharper and capable of more precise determination.

The significance of events is more complex. In the first place they are mutually significant of each other. The uniform significance of events thus becomes the uniform spatio-temporal structure of events. In this respect we have to dissent from Einstein who assumes for this structure casual heterogeneity arising from contingent relations. Our consciousness also discloses to us this structure as uniformly stratified into durations which are complete nature during our specious presents. These stratifications exhibit the patience of fact for finite consciousness, but then they are in truth characters of nature and not illusions of consciousness.

Returning to the significance of events, we see that there is no such thing as an isolated event. Each event essentially signifies the whole structure. But furthermore, there is no such entity as a bare event. Each event also signifies objects, other than events which are in essential relation to it. In other words the passage of an event exhibits objects which do not pass. I have termed the natural factors which are not events but are implicated in events 'objects,' and awareness of an object is what I have termed recognition. Thus green is an object and so is a blade of grass, and awareness of green or of a blade of grass is recogni-

tion. Thus an event signifies objects in mutual relations. The particular objects and their particular relations belong to the sphere of contingence; but the event is essentially a 'field,' in the sense that without related objects there can be no event. On the other hand related objects signify events, and without such events there are no such objects.

The celebrated two-termed relationship of universals to the concrete particulars which they qualify is merely a particular example of the general doctrine of significance and patience. The universals are significant of their particulars, and the particulars are factors exhibiting the patience of fact for those universals.

But in the apparent world, that is to say, in the world of nature disclosed by sense-awareness, no example of the simple two-termed relationship of a universal signifying its particular is to be found. Green appears to an observer in a situation distinct from that of the observer, but simultaneous with it. Thus there is essential reference to three simultaneous events, the event which is the bodily life of the observer, called the percipient event, and the event which is the so-called situation of the green at the time of observation, and to the time of observation which is nothing else than the whole of nature at that time. Under the obsession of the logical theory of universals and concrete particulars the percipient event was suppressed, and the relation of green to its situation represented as universal qualifying particular. It was then noted that this relation only holds for the particular observer, and that furthermore account must be taken of contingent circumstances such as the transmission of something, which is not the colour green, from an antecedent situation to the percipient event.

This process, of first presupposing a two-termed relation and then finding that it is not true, has led to the bifurcation which places green in the observer's mind, qualifying a particular also in the observer's mind; while the whole mental process has some undetermined relation to another system of entities variously described either as an independent physical universe in some causal relation to mind or as a conceptual model.

I have argued elsewhere in detail that this result is untenable. Here I will only remark that if we incline to adopt the physical universe, we can find no shred of evidence for it, since everything apparent for consciousness has been accounted for as being in the observer's mind; while, if we turn to the conceptual model, it is also the model for the same consciousness. Accordingly whichever choice we make there will

be no shred of evidence for anything other than the play of that consciousness at one moment of self-realisation. For recollection and anticipation are merely the play of immediate consciousness. Thus on either alternative, solipsism only is left and very little of that.

Meanwhile the whole difficulty has arisen from the initial error of forcing the complex relations between green and the structure of events into the inadequate form of a two-termed relation.

Yet after all the search for universals to qualify events in the simple two-termed manner does represent a justifiable demand. We want to know what any particular event A is in itself apart from its reference to other events. By this I mean, we want to determine how A can enter into a two-termed relation of contrast with any other factor X without having necessarily to enlarge the relationship by including other events B, C, D, by way of determining A. For example, the colour green is in itself different from red, and we do not have to specify green or red by their diverse relationships amid events in order to appreciate their contrast. Now we want to do much the same thing for events, so as to feel that an event has a character of its own. We have seen that the immediate objects of the apparent world such as colours do not satisfy the requisite conditions since their reference to events involves the relations of the percipient event to the so-called situation. I call such objects of immediate appearance, sense-objects. Colours, sounds, smells, touches, pushes, bodily feelings, are sense-objects. But after all, the way we do connect these sense-objects, as I call them, with their situations shows that awareness of an event carries with it apprehension of that event as patient of a character qualifying it individually. In fact every event signifies a character for itself alone, but what exactly that character may be lies within the sphere of contingency and is not disclosed in our immediate consciousness of the apparent world. I will call such a character an adjective of its event. An adjective marks a breakdown in relativity by the very simplicity of the two-termed relation it involves. The discovery of these missing adjectives is the task of natural science. The primary aim of science is to contract the sphere of contingency by discovering adjectives of events such that the history of the apparent world in the future shall be the outcome of the apparent world in the past. There obviously is some such dependence, and it is the purpose of science to express this dependence in terms of adjectives qualifying events. In order to understand this procedure of science, there are three concepts which we must understand. They are

(i) The structure of the four dimensional continuum,
(ii) Pervasive adjectives and adjectival particles,
(iii) The atomic field of an adjectival particle.

I will conclude this lecture by considering them in order.

(i) *The structure of the continuum of events*

This structure is four-dimensional, so that any event is a four-dimensional hyper-volume in which time is the fourth dimension. But we should not conceive an event as space and time, but as a unit from which space and time are abstracts.

An event with all its dimensions ideally restricted is called an 'event-particle,' and an event with only one dimension of finite extension is called a 'route' or 'path.' I will not in this lecture discuss the meaning of this ideal restriction. I have investigated it elsewhere under the name of 'extensive abstraction.'

The structure is uniform because of the necessity for knowledge that there be a system of uniform relatedness, in terms of which the contingent relations of natural factors can be expressed. Otherwise we can know nothing until we know everything. If P be any event-particle, a moment through P is a system of event-particles representing all nature instantaneously contemporaneous with P. According to the classical view of time there can be only one such moment. According to the modern view there can be an indefinite number of alternative moments through P, each corresponding to a different meaning for time and space. A moment is an instantaneous three-dimensional section of nature and is the entity indicated when we speak of a moment of time.

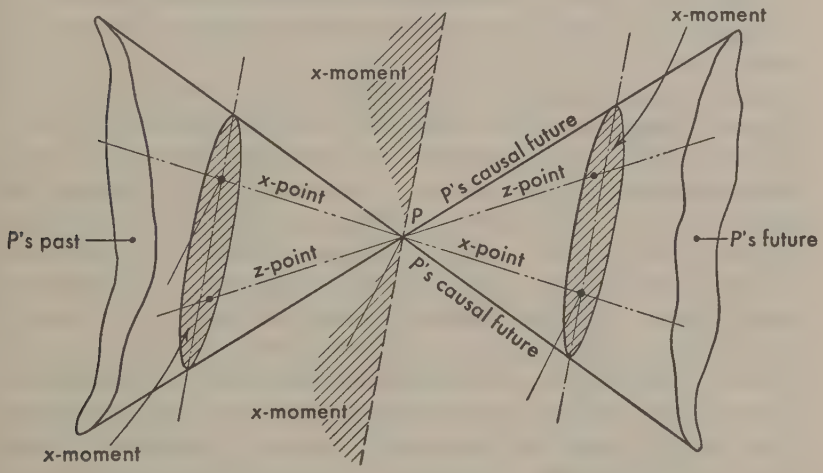
The aggregate of event-particles lying on moments through P will be called the region co-present with P. The remainder of the four-dimensional continuum is divided by the co-present region into two regions, one being P's past and the other being P's future. The three-dimensional boundary between P's past and P's co-present region is P's causal past, and the corresponding boundary between P's future and P's co-present region is P's causal future. The remaining portion of P's future is P's kinematic future.

A route lying entirely in one moment is called a spatial route, and a route which lies entirely in the past and future of each one of its event-particles is called a historical* route.

* I borrow the term 'historical' from Prof. C. D. Broad.

(ii) *Pervasive adjectives and adjectival particles*

We gain great simplicity of explanation, without loss of any essential considerations by confining our consideration of events to routes. These routes are of course not true events, but merely ideal limits with only one dimensional extension remaining.



A factor will be said to be an adjective pervading a route when it is an adjective of every stretch of the route. Such a factor will be called a pervasive adjective, or uniform object. I think—without being very certain—that true pervasive adjectives are only to be found qualifying historical routes; but that pervasive pseudo-adjectives also qualify spatial routes. The essential difference between time and space finds its illustration in the difference between these two different types of route.

As an illustration of pervasive adjectives, consider a mass-particle *m*. The enduring existence of this particle marks out a historical route amid the structure of events. In fact the mass-particle is merely a pervasive adjective of that route, since it is an adjective qualifying in the same sense every stretch of that route. But here a further explanation is necessary. The mass-particle as a pervasive adjective is a universal and has lost its concrete individuality.

Another mass-particle of the same mass pervading another historical route is the same pervasive adjective also qualifying every stretch of that other route. It follows that the separate concrete individualities of the

two mass-particles arise from the separate individualities of their two historical routes. Thus a concrete mass-particle is the fusion of a pervasive adjective with the individuality of a historical route. We say that a mass-particle is situated at each event-particle of its historical route. I will call a pervasive adjective as qualifying a particular historical route an 'adjectival particle.' The principle underlying the conception of an adjectival particle is that the individual embodiment of character always involves process and that this process is here represented by the historical route.

Spatial routes cannot be pervaded by mass-particles. Thus if a mass-particle of the same mass be situated at each event-particle of a spatial route, that route is not pervaded by the one adjective which is the same universal for each of the concrete mass-particles. In fact a stretch of the spatial route is qualified by quite a different adjective, which represents the sum of the masses situated at the event-particles of the stretch. Accordingly spatial routes and historical routes function quite differently in respect to the adjective 'mass m,' and thus illustrate the difference between the spread of space and the lapse of time.

There are however pseudo-adjectives which do pervade spatial routes. Consider a sense-object, such as the colour red. It is not a true adjective of its situation, since there is always a necessary reference to a percipient event. But for the one observer conscious of the natural relations of that percipient event, who is pre-supposing this reference to his bodily life as a condition for appearance, the colour red is an adjective of its situation. But any part of its situation is also red, neither more nor less so than the whole enduring patch of red. Thus red pervades its situation. However I have already argued at length that sense-objects are not true adjectives. They simulate adjectives for an observer who in his intellectual analysis of the circumstances forgets to mention himself. Accordingly they may be called pervasive pseudo-adjectives.

The common material objects of perception, such as chairs, stones, planets, trees, etc., are adjectival bodies pervading the historical events which they qualify. In so expressing myself, I have gone beyond the ideal simplicity of a route, and the terms 'pervasion' and 'historical event' require, strictly speaking, a more elaborate explanation than I have yet given. In this lecture however it is unnecessary to undertake the task, and I need only refer to my *Principles of Natural Knowledge* where the requisite definitions are given in connection with uniform objects.

(iii) *The atomic field of an adjectival particle*

Science has been driven to have recourse to more precisely delimited adjectival objects than these adjectival objects of perception. The standard types of such objects are mass-particles and electrons; and we will fall back on our ideal simplicities by conceiving them as adjectival particles defined, as above, for the ideal simplification of historical routes.

Now the essence of an adjectival object, whether it be the unprecise object of perception or the more precise object of science, is that it reduces the contingency of nature. It is an adjective of events which to some extent conditions the possibilities of apparent sense-objects.

It must be admitted that it is itself a contingent adjective. But owing to the simplicity of the relation of an adjective to its qualified substance, it involves a simpler contingency than the contingency of the complex relationships of sense-objects. In other words we are limiting contingency by the fixed conditions which are the laws of nature.

It is evident therefore that a scientific object must qualify future events. For otherwise the future contingency is unaffected by it. In this a scientific object differs decisively from a sense-object viewed as a pseudo-adjective. A sense-object qualifies events in the present. It is confined to a spatial region with the minimum of historicity requisite for the duration of the present. Whereas the scientific object qualifies a region extending from the present into the future. Thus the seemingly contingent play of the senses is controlled by the conditions introduced by its dependence upon the qualification of events introduced by scientific objects. A scientific object qualifies the future in two ways, (*a*) by its permanence and (*b*) by its field.

Let us take the permanence first. The permanence of an adjectival particle lets us know that there will be some historical route pervaded by that particle. It does not in itself tell us more than that some pervaded route will stretch into the future from the situation in the present. The permanence of the unique particle is nothing else than the continuity of the unique historical route, and its pervasion by the adjectival particle.

The further laws of physical science represent the further conditions which determine, or partially determine, the particular historical routes pervaded by these adjectival particles. The most simple expression of such a law consists in associating an atomic field with each adjectival particle as situated in each one of the event-particles of its pervaded route. Again this association of the field represents another eruption of

contingency, but also again this contingency is of a simple defined type. The field of an adjectival particle m at a situation P is a limited region stretching from P into P's futurity. This region is qualified by an adjective dependent upon m and P only. For this simple type of law, the only limited region which can satisfy this demand is the three-dimensional boundary region between P's co-present and P's kinematic future. I have called this region P's causal future. Accordingly the field of m at P must be P's causal future. Expressing this statement in terms of one consistent meaning for time and its associated permanent space, we first note that P consists of a point S_P at a time t_P, and m situated in P means m at the point S_P at the time t_P. The causal future of P means those points S_B, at times t_B [i.e. those event-particles such as B], reached by a physical character due to m, and starting from S_P at time t_P and arriving at S_B at time t_B, and travelling with the critical maximum velocity c.

Experiment shows that this critical maximum velocity is a near approximation to the velocity of light *in vacuo*, but its definition in no way depends upon any reference to light. Thus the adjectival character of the field of m at P consists in the correlated physical characters of the different event-particles of the field. The whole conception is practically the familiar one of tubes of force, with one exception. A tube of force is conceived statically as a simultaneous character stretching through space. This statical conception destroys the true individuality of a tube by piecing together fragments of different tubes. As we pass along a tube radiating from S_P we keep to the same tube by allowing for the lapse of time required by the velocity c.

The peculiar correlation of adjectives attaching to the various event-particles of the field of m at P will depend upon the particular contingent law which science conjectures to be the true expression of m's physical status.

There are, also, less simple laws of nature for which the influence of the contingent configurations of other adjectival particles will be essential factors. Such laws will in general involve the deflection of the field of m at P from P's causal future into P's kinematic future. The region will be dependent upon the fields of the other relevant adjectival particles. It is evident that with such laws we are rapidly drifting towards the difficulty of having to know everything before knowing anything.

I will call such fields 'obstructed fields.' Differential equations help us here. But even their aid would be unavailing unless we could approximate from the first assumption of unobstructed fields for the adjectival

particles producing the obstruction. In this way the influence of gravitation upon the electromagnetic field can be calculated and *vice versa.*

This account of the status of scientific objects completely changes the status of the ether from that presumed in nineteenth century science. In the classical doctrine the ether is the shy agent behind the veil: in the account given here the ether is exactly the apparent world, neither more nor less. The apparent world discloses itself to us as the ingression of sense-objects amid events. In this statement the term 'ingression' is used for the complex relationship of those abstract elements of the world, such as sense-objects, which are devoid of becomingness and extension, to those other more concrete elements (events) which retain becomingness and extension. But a bare event is a mere abstraction. Events are disclosed as involved in this relationship of ingression. This disclosure is our perceptual vision of the apparent world. We now ask on behalf of science whether we cannot simplify the regulative principles discerned in this apparent world by treating events as something more than relata in the relationship of ingression. Cannot we discern true Aristotelian qualities as attaching to the events? Is not each event something in itself, apart from its status as a mere relatum in the relationship of ingression? The apparent world itself gives an answer, partially in the affirmative. Chairs, tables, and perceptual objects generally, have lost the complexity of ingression, and appear as the required Aristotelian adjectives of some events. Their appearance involves that borderline where sense-awareness is fusing with thought. It is difficult to make any account of them precise. In fact, for the purpose of science they suffer from incurable vagueness. But they mark the focal centres to be used as the radiating centres for an exact account of true Aristotelian adjectives without any of those qualifications here referred to as 'vagueness.' The events of the apparent world as thus qualified by the exact adjectives of science are what we call the 'ether.' Accordingly in my previous work, *The Principles of Natural Knowledge*, I have phrased it in this way, that the older 'ether of stuff' is here supplanted by an 'ether of events.'

This line of thought, supplanting 'stuff' by 'events,' and conceiving events as involving process and extension and contingent qualities and as primarily relata in the relationship of ingression, is a recurrence to Descartes' views—with a difference. Descartes, like the rest of the world at that time, completely dissociated space and time. He assigned extension to space, and process to time. It is true that time involves extension

of some sort, but that does not seem to have coloured his philosophy. Now according to Descartes 'extension' is an abstract from the more concrete concept of 'stuff.' He, like the rest of the world, considers stuff as being separable from the concept of 'process,' so that stuff fully realises itself *at* an instant, without duration. Space is thus a property of stuff, and accordingly follows stuff in being essentially dissociated from time. He therefore deduces that space is an essential timeless plenum. It is merely an abstract from the concrete world of appearance *at an instant*. If there be no stuff to appear, there can be no space.

Now re-write this Cartesian account of space, substituting 'events' (which retain 'process') for 'stuff' (which has lost 'process'). You then return to my account of space-time, as an abstract from events which are the ultimate repositories of the varied individualities in nature. But space as pure extension, dissociated from process, and time as pure serial process, are correlative abstractions which can be made in different ways, each way representing a real property of nature. In this manner the alternative spaces and the alternative times, which have already been mentioned, are seen to be justifiable conceptions, according to the account of the immediate deliverances of awareness here given, provided that our experience can be thereby explained.

Mere deductive logic, whether you clothe it in mathematical symbols and phraseology or whether you enlarge its scope into a more general symbolic technique, can never take the place of clear relevant initial concepts of the meaning of your symbols, and among symbols I include words. If you are dealing with nature, your meanings must directly relate to the immediate facts of observation. We have to analyse first the most general characteristics of things observed, and then the more casual contingent occurrences. There can be no true physical science which looks first to mathematics for the provision of a conceptual model. Such a procedure is to repeat the errors of the logicians of the middle-ages.

CHAPTER III *EQUALITY*

The criticism of the meanings of simple obvious statements assumes especial importance when any large reorganisation of current ideas is

in progress. The upheaval produced by the Einstein doctrine of relativity is a case in point. It demands a careful scrutiny of the fundamental ideas of physical science in general and of mathematical physics in particular. I propose therefore in this lecture to take one of the simplest mathematical notions which we all come across when we start mathematics in our early school life and to ask what it means.

The example I have chosen is the notion of 'equality.' There is hardly a page or a paragraph of any mathematical book which does not employ this idea. It appears in geometry in the more specialised form of congruence.

If I am not mistaken, clear notions on equality are of decisive importance for the sound reconstruction of mathematical physics. Congruence is a more special term than equality, being confined to mean the quantitative equality of geometrical elements. Equality is also closely allied to the idea of quantity; but here again I think that equality touches the more general ideas. The consideration of quantity necessarily introduces that of measurement. In fact the scope of a discussion on quantity may be defined by the question, How is measurement possible? Lastly, equality has an obvious affinity with identity. Some philosophers in considering the foundations of mathematics would draw no distinction between the two. In certain usages of equality this may be the case. But it cannot be the whole truth. For if it were, the greater part of mathematics would consist of a reiteration of the tautologous statement that a thing is itself. We are interested in equality because diversity has crept in.

In fact a discussion of equality embraces in its scope congruence, quantity, measurement, identity and diversity. The importance of equality was discovered by the Greeks. We all know Euclid's axiom, 'Things that are equal to the same thing are also equal to one another' (*τὰ τῷ αὐτῷ ἴσα καὶ ἀλλήλοις ἐστὶν ἴσα*). This axiom deserves its fame, in that it is one of the first efforts to clarify thought by an accurate statement of premises habitually assumed. It is the most conspicuous example of the decisive trend of Greek thought towards rigid accuracy in detailed expression, to which we owe our modern philosophy, our modern science, and the creeds of the Christian Church. But grateful as we are to the Greeks for this axiom and for the whole state of mind which it indicates, we cannot withdraw it from philosophic scrutiny. The whole import of the axiom depends on the meaning of the word *ἴσος*, equal. What do we mean when we say that one thing is equal to

another? Suppose we explain by stating that 'equal' means 'equal in magnitude,' that is to say, the things are quantities of the same magnitude. But what is a quantity? If we define it as having the property of being measurable in terms of a unit, we are thrown back upon the equality of different examples of the same unit. It is evident that we are in danger of soothing ourselves with a vicious circle whereby equality is explained by reference to quantity and quantity by reference to equality.

Let us first drop the special notion of quantitative equality and consider the most general significance of that notion. The relation of equality denotes a possible diversity of things related but an identity of character qualifying them. It is convenient for technical facility in the arrangement of deductive trains of reasoning to allow that a thing is equal to itself, so that equality includes identity as a special case. But this is a mere matter of arbitrary definition.

The important use of equality is when there is diversity of things related and identity of character. This identity of character must not be mere identity of the complete characters. For in that case, by the principle of the identity of indiscernables, the equal things would be necessarily identical.

Accordingly when we write

$$A = B$$

we are referring implicitly to some character and asserting that A and B both possess it. The assertion of equality is therefore generally couched in a highly elliptical form since the expression of the character in question is often omitted. This is a source of most of the confused thinking which haunts discussion on this subject. Let us remedy our notation so as to rid it of its misleading ellipticity. Let $(c_1, c_2, \ldots, c_n)$ denote a class of characters $c_1, c_2, \ldots, c_n$, such as colour for example.

Then we write

$$A = B \rightarrow (c_1, c_2, \ldots, c_n)$$

to mean that A and B both possess the same character out of the set $(c_1, c_2, \ldots, c_n)$; and we write

$$A \neq B \rightarrow (c_1, c_2, \ldots, c_n)$$

to mean that different characters out of the set apply to A and B respectively. Our notation still has the defect of implying that the class of characters is a finite or at least an enumerable class. Let us therefore take γ to represent this class, so that

$$A = B \rightarrow \gamma$$

means that the same member of the class γ qualifies both A and B; and

$$A \neq B \rightarrow \gamma$$

means that one member of γ qualifies A and that another member of γ qualifies B. I will call γ the 'qualifying class.'

It is now evident that

$$A = B \rightarrow \gamma$$

and

$$B = C \rightarrow \gamma$$

implies that

$$A = C \rightarrow \gamma.$$

This is evidently a general rendering of Euclid's first axiom.

But we are not yet at the end of our discussion. In the first place, we cannot yet prove that

$$A = B \rightarrow \gamma$$

and

$$A \neq B \rightarrow \gamma$$

are incompatible with each other. For we have not yet excluded the case that more than one character of the set γ may attach either to A or to B or to both. For example if c_1 and c_2 are members of γ, both attaching to A, but only c_1 attaching to B, then both

$$A = B \rightarrow \gamma$$

and

$$A \neq B \rightarrow \gamma.$$

Accordingly we must re-define the meaning of our symbols by introducing the additional limitation that

$$A = B \rightarrow \gamma$$

and

$$A \neq B \rightarrow \gamma$$

both mean that A and B each possess one and only one character of the class γ. It is well to note that the two propositions represented by these symbolic statements are only contraries to each other. For though they cannot both be true, they will both be false if either A or B does not possess any character out of the qualifying class γ. For example if A does not possess any such quality or if it possesses two such qualities, then

$$A = A \rightarrow \gamma$$

and

$$A \neq A \rightarrow \gamma$$

are both false. This example also illustrates the sharp distinction between equality and mere identity.

In this most general sense of equality, the notion of 'matching,' in the sense in which colours match, might with advantage replace equality, so that we should interpret

$$A = B \rightarrow \gamma \text{ and } A \neq B \rightarrow \gamma$$

as meaning respectively

'A matches B in respect to the qualities γ'

and

'A does not match B in respect to the qualities γ.'

This verbal statement in its common meaning presupposes our three conditions:

(i) that A and B each possess one of the qualities γ,

(ii) that neither A nor B possesses more than one such quality,

(iii) that A and B possess the same one of the qualities γ, and (in the second case) that A and B do not possess the same one of the qualities.

The set of entities such as A and B possessing one and only one of the qualities of the class γ will be said to form the 'qualified class for γ,' and we have already named γ the 'qualifying class.'

Congruence. Congruence is a subspecies of the general type of the equality relation. Let us start with the simplest example and consider a one-dimensional space. The points of this space are terms interconnected by a relation which arranges them in serial order with the ordinary continuity of the Dedekindian type. The points may be connected by other relations which sort them out in other ways; but when we say that they form a one-dimensional space, we are thinking of one definite relation which produces the continuous serial order, both ways infinite.

Now in the particularising of the equality relation so as to produce a congruence relation for this space, we first demand that, if γ be the qualifying class, the class qualified by γ must be composed of all the finite stretches of the space. Thus the terms A, B, etc. in the previous explanation of equality are now stretches of the serial space, and every finite stretch belongs to the qualified class. It will be convenient to confine attention to those stretches which include their two end-points. Let two stretches which do not overlap, except that they have one end-point in common, be called adjoined stretches, or stretches adjoined at that end-point.

Now the conditions which have to be fulfilled in order that this type of equality may reckon as a congruence are:

(i) If A be any stretch and p any point, there are two stretches P_1 and P_2 adjoined at p, such that

$$A = P_1 \rightarrow \gamma$$

and

$$A = P_2 \rightarrow \gamma.$$

In other words, from a given point p stretches of an assigned length can be measured in either direction.

(ii) If P and Q are two stretches, and P contains Q, then

$$P \neq Q \rightarrow \gamma.$$

In other words, the whole is unequal to its part.

(iii) If P and Q be two stretches, and P be composed of the adjoint stretches P_1 and P_2, and Q of the adjoint stretches Q_1 and Q_2, and furthermore if

$$P_1 = Q_1 \rightarrow \gamma$$

and

$$P_2 = Q_2 \rightarrow \gamma,$$

then

$$P = Q \rightarrow \gamma.$$

In other words, if equals be added to equals the wholes are equal.

(iv) If the first clause of the hypothesis of (iii) holds, and furthermore if

$$P = Q \rightarrow \gamma$$

and

$$P_1 = Q_1 \rightarrow \gamma,$$

then

$$P_2 = Q_2 \rightarrow \gamma.$$

In other words, if equals be taken from equals the remainders are equal.

(v) The axiom that the whole is greater than its part suffers from the difficulty that we have not defined what we mean by 'greater than.' Our condition (ii) states that the whole is unequal to its part. But the idea of 'greater than' really follows from the condition which we wish to express. I think that the missing condition is best stated thus:

Let A and B be two stretches of which one contains the other, so that either A contains B or B contains A, and let H and K be two other stretches with the same property in regard to each other.

Also let

$$A = H \rightarrow \gamma,$$

$$B = K \rightarrow \gamma.$$

Then if H contains K, it also follows that A contains B. The point of

this condition is that we exclude the crosswise equality in which A is congruent to a part of H and H to a part of A.

Then the idea of any stretch P being greater than any stretch Q must be defined to mean that there is a stretch H containing a part K such that

$$P = H \rightarrow \gamma,$$
$$Q = K \rightarrow \gamma.$$

Thus the verbal form, the whole is greater than its part, becomes a mere tautology. The true point being first our condition (ii) that the whole is unequal to any of its parts, and our condition (v) which excludes the crosswise equality of wholes to parts.

The theory of numerical measurement depends upon three additional conditions which can be conveniently preceded by some definitions. Let a sequence of n successively adjoined stretches $A_1, A_2, \ldots, A_n$, which is such that

$$A_p = A_q \rightarrow \gamma, [p, q = 1, 2, \ldots, n]$$

be called a 'stretch sequence for γ.' Let each individual stretch of the sequence be called a 'component stretch' of the sequence, and let the stretch which is composed of all the stretches of the sequence be called the 'resultant stretch' of the sequence.

Furthermore if c be the member of γ which characterises each component stretch of the sequence of n stretches, let nc be the symbol for the member of γ which characterises the resultant stretch of the sequence.

Also if c' be an alternative symbol for nc, let $\frac{1}{n}c'$ be an alternative symbol for c.

The three conditions are:

(vi) If A be any stretch and n be any integer, then a stretch sequence for γ can be found composed of n members such that A is its resultant.

(vii) If A and B be any two coterminous stretches, and A be part of B, then we can find an integer n such that there exists a stretch sequence for γ of n terms such that A is its first term and B is part of the resultant of the sequence.

(viii) If A be any stretch and n any integer, then A is a member in any assigned ordinal position of two stretch sequences for γ of n terms, the two sequences running in opposed directions.

The condition (vii) is the axiom of Archimedes.

It is evident that we may conceive γ as the class of magnitudes and the stretches as the class of concrete quantities. The difference between a magnitude and a concrete quantity is the difference between the length, called a yard, and the particular concrete instance which is in the custody of the Warden of the Standards.

It is not necessary to plunge further into the exact analysis of the theory of extensive quantity. The discussion has been carried far enough to make it evident that the qualifying class γ, which is the class of magnitudes, is simply a class of qualities which happen to be sorted out among the qualified class (which in the above example was a class of stretches) in such a way that, when one member of γ has been taken as the standard of reference, the unit, all the other members of γ can be described in terms of it by means of real numbers. But a quality which belongs to the set γ is in itself in no way otherwise distinguished from any other quality of things. Quantity arises from a distribution of qualities which in a certain definite way has regard to the peculiar fact that in certain cases two extended spatio-temporal elements together form a third such element. In fact the 'qualifying' qualities are distributed among extended things with a certain regard to their property of extension. Also it is evident that two stretches A and B which are equal for one qualifying class γ may be unequal for another qualifying class γ'.

If we apply this doctrine to the classical theory of space and time, we find, following Sophus Lie's analysis, that there are an indefinite number of qualifying classes γ, γ', γ'', etc., which for the case of three-dimensional space generate relations of congruence among spatial elements, and that each such set of congruence relations is inconsistent with any other such set.

For the case of time the opposite trouble arises. Time in itself, according to the classical theory, presents us with no qualifying class at all on which a theory of congruence can be founded.

This breakdown of the uniqueness of congruence for space and of its very existence for time is to be contrasted with the fact that mankind does in truth agree on a congruence system for space and on a congruence system for time which are founded on the direct evidence of its senses. We ask, why this pathetic trust in the yard-measure and the clock? The truth is that we have observed something which the classical theory does not explain.

It is important to understand exactly where the difficulty lies. It is often wrongly conceived as depending on the inexactness of all measure-

ments in regard to very small quantities. According to our methods of observation we may be correct to a hundredth, or a thousandth, or a millionth of an inch. But there is always a margin left over within which we cannot measure. However this character of inexactness is not the difficulty in question.

Let us suppose that our measurements can be ideally exact; it will be still the case that if one man uses one qualifying class γ and the other man uses another qualifying class δ, and if they both admit the standard yard kept in the exchequer chambers to be their unit of measurement, they will disagree as to what other distances at other places should be judged to be equal to that standard distance in the exchequer chambers. Nor need their disagreement be of a negligible character. For example, the man who uses the qualifying class γ might be in agreement with the rest of us, who are also using γ, and the other man who uses δ might also be a well-trained accurate observer. But in his measurement the distance from York to Edinburgh might come out at exactly one yard.

But no one, who is not otherwise known to be a lunatic, is apt to make such a foolish mistake.

The conclusion is that when we cease to think of mere abstract mathematics and proceed to measure in the realm of nature, we choose our qualifying class γ for some reason in addition to the mere fact that the various characters included in γ are sorted among stretches so as to satisfy the conditions for congruence which I have jotted down above.

When we say that two stretches match in respect to length, what do we mean? Furthermore we have got to include time. When two lapses of time match in respect to duration, what do we mean? We have seen that measurement presupposes matching, so it is of no use to hope to explain matching by measurement.

We have got to dismiss from our minds all considerations of number and measurement and quantity, and simply concentrate attention on what we mean by matching in length.

It is an entirely different and subsequent consideration as to whether length in this sense of the term is a class of qualities which is sorted out to stretches in accordance with the congruence conditions.

Our physical space therefore must already have a structure and the matching must refer to some qualifying class of qualities inherent in this structure. The only possible structure is that of planes and straight lines,

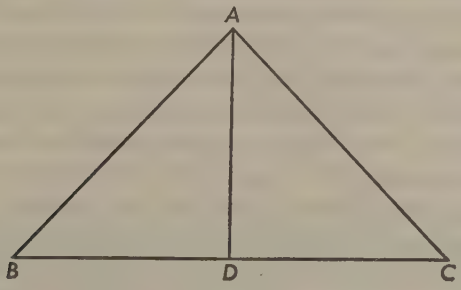
such that stretches of straight lines can be conceived as composed of points arranged in order.

An additional factor of structure can be that of ordinary Euclidean parallelism. By this I mean that through any point outside a plane there is one and only one plane which does not intersect a given plane. You will observe that I have had to adopt what is termed Playfair's axiom for the definition of parallels. It is the only one which does not introduce some presupposition of congruence, either of length or angles. I draw your attention to the absolute necessity of defining our structure without the presupposition of congruence. If we fail in this respect our argument will be involved in a vicious circle.

With this definition of parallels it is now very easy to get some way in the explanation of what we mean by stretches matching in length. For since our structure includes parallels, it also includes parallelograms. Accordingly we can agree that the opposite sides of parallelograms match in length. It is then easy enough to show that we have a complete system of congruence for any one system of parallel stretches in space. This means that if there are any two stretches either on the same straight line or on parallel straight lines, we have a definitely determined numerical ratio of the length of one to the length of the other.

But we cannot go further and compare the lengths of two stretches which are not parallel, unless we introduce some additional principle for the matching of lengths.

We can find this additional principle provided that we can define a right-angle without any appeal to the idea of congruence or equality. For let us anticipate such a definition independent of congruence.



Let D be the midpoint of the stretch BC, and draw DA perpendicular to BC. Then our additional principle of matching shall be that AB is

equal to AC. In this way we can compare the lengths of stretches which are not parallel, and the whole theory of congruence in space is established.

But as yet we have not gone any way towards finding any theory for the congruence of lapses of time. Accordingly if we are to explain how it is that in our observation of nature we all agree in our systems of space and time congruence, we have to explain what we mean by planes, and by right-angles, and how we should match lapses of time. We can omit straight lines from this catalogue, since they can be defined as the intersections of planes. We shall however have to explain how the points on straight lines come to be arranged in order.

When we are conscious of nature, what is it that we really observe? The obvious answer is that we perceive various material bodies, such as chairs, bricks, trees. We can touch them, see them and hear them. As I write I can hear the birds singing in a Berkshire garden in early spring.

In conformity with this answer, it is now fashionable and indeed almost universal to say that our notions of space merely arise from our endeavours to express the relations of these bodies to each other. I am sorry to appear pigheaded; but, though I am nearly in a minority of one, I believe this answer to be entirely wrong. I will explain my reasons.

Are these material bodies really the ultimate data of perception, incapable of further analysis?

If they are, I at once surrender. But I submit that plainly they have not this ultimate character. My allusion to the birds singing was made not because I felt poetical, but to warn you that we were being led into a difficulty. What I immediately heard was the song. The birds only enter perception as a correlation of more ultimate immediate data of perception, among which for my consciousness their song is dominant.

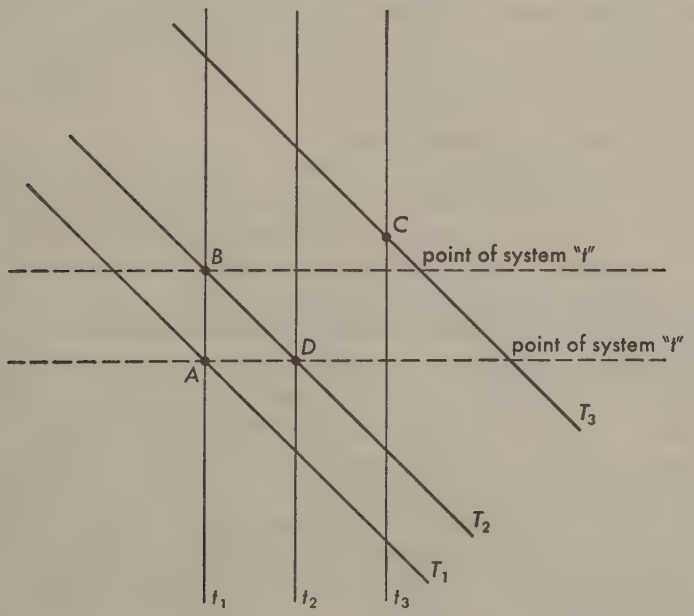
Material bodies only enter my consciousness as a representation of a certain coherence of the sense-objects such as colours, sounds and touches. But these sense-objects at once proclaim themselves to be adjectives (pseudo-adjectives, according to the previous chapter) of events. It is not mere red that we see, but a red patch in a definite place enduring through a definite time. The red is an adjective of the red time and place. Thus nature appears to us as the continuous passage of instantaneous three-dimensional spatial spreads, the temporal passage adding a fourth dimension. Thus nature is stratified by time. In fact passage in time is of the essence of nature, and a body is merely the

coherence of adjectives qualifying the same route through the four-dimensional space-time of events.

But as the result of modern observations we have to admit that there are an indefinite number of such modes of time stratification.

However, this admission at once yields an explanation of the meaning of the instantaneous spatial extension of nature. For it explains this extension as merely the exhibition of the different ways in which simultaneous occurrences function in regard to other time-systems.

I mean that occurrences which are simultaneous for one time-system appear as spread out in three dimensions because they function diversely for other time-systems. The extended space of one time-system is merely the expression of properties of other time-systems.



According to this doctrine, a moment of time is nothing else than an instantaneous spread of nature. Thus let t_1, t_2, t_3 be three moments of time according to one time-system, and let T_1, T_2, T_3 be three moments of time according to another time-system. The intersections of pairs of moments in diverse time-systems are planes in each instantaneous three-dimensional space. In the diagram each continuous line accord-

ingly symbolises a three-dimensional space; and the intersections of continuous lines, such as A or B or C, symbolise planes. Thus t_1 and T_1 are each a three-dimensional space, and A is a plane in either space.

Parallelism is the reflection into an instantaneous space of one time-system of the property of moments of some other system. Thus A and B are parallel planes in t_1, since T_1 and T_2 are moments of the same system which is not the system to which t_1 belongs.

But when we talk of space we are not usually thinking of the instantaneous fact of immediate perception. We are thinking of an enduring scheme of extension within which all these instantaneous facts are fitted. It follows that we ought to be able to find a meaning for the idea of a permanent space in connection with each time-system.

This conception must arise from our immediate observations of motion and rest. Both rest and motion have no meaning in connection with one mere instantaneous space. In such a space everything is where it is and there is an instantaneous end to it; to be succeeded by another instantaneous space. But motion and rest at once warn us that our perception involves something more.

The instantaneous moment is merely an ideal limit of perception. Have you ever endeavoured to capture the instantaneous present? It eludes you, because in truth there is no such entity among the crude facts of our experience. Our present experience is an enduring fact within which we discriminate a passage of nature. Now within this enduring fact we observe rest and motion. A body at rest in the space of our observation is tracing out a certain historical route intersecting the moments of our time-system in a sequence of instantaneous points. This route is what we mean by a point of the permanent space of our time-system. Thus each time-system has its own space with its own points, and these permanent points are loci of instantaneous points.

The paradoxes of relativity arise from the fact that we have not noticed that when we change our time-system we change the meaning of time, the meaning of space and the meaning of points of space (conceived as permanent).

Now the route of a small body at rest in the space of a time-system, that is to say, a point of that time-system, has a certain symmetry in respect to the successive instantaneous spaces of that system, which is expressed for us by the perception of lack of change of position. This symmetry is the basis of the definition of rectangularity.

If the body be at rest in the space of the time-system t, it is moving

in a straight line in the space of another time-system T. This permanent straight line intersects any moment of T, say T_1, in an instantaneous straight line l_1 (say). Then l_1 is perpendicular to the series of instantaneous parallel planes in which the moments of system t intersect T_1. In other words the planes to which motion is perpendicular are the planes of intersection with the moments of that time-system for whose space that motion would be represented as rest.

We have thus defined both parallelism and perpendicularity without reference to congruence, but in terms of immediate data of perception. Furthermore, the parallelism of the moments of one time-system enables us to extend parallelism to time as also expressing the relation to each other of permanent points of the same time-system. It thus follows that we now possess a structure in terms of which congruence can be defined. This means that there will be a class of qualities γ one and only one of which attaches to any stretch on a straight line or on a point, such that matching in respect to this quality is what we mean by congruence.

The thesis that I have been maintaining is that measurement presupposes a perception of matching in quality. Accordingly in examining the meaning of any particular kind of measurement we have to ask, What is the quality that matches?

Furthermore, in applying this doctrine to measurements in space and time, I have maintained that the things whose qualities match are events. In other words, I maintained that it is events that are congruent, and that spatial congruence and temporal congruence are merely special instances of this fundamental congruence. In conformity with this doctrine I also maintain that space and time are merely the exhibition of relations between events.

The usual opinion, or at any rate the more usual mode of expression, is that space and time are relations between the material objects implicated in events. It is difficult to understand how time can be a relation between two permanent objects. Also with the modern assimilation of time and space, this difficulty in respect to time also attaches to space. Furthermore, I hold that these permanent objects are nothing else than adjectives of events. It follows that a yard measure is merely a device for making evident the spatial congruence of the events in which it is implicated.

The divergence between the two points of view as to space-time, that is to say, as to whether it exhibits relations between events or relations

between objects in events is really of the utmost importance in the stage of physical science. If it be a relatedness between events, it has the character of a systematic uniform relatedness between events which is independent of the contingent adjectives of events. In this case we must reject Einstein's view of a heterogeneity in space-time. But if space-time be a relatedness between objects, it shares in the contingency of objects, and may be expected to acquire a heterogeneity from the contingent character of objects. I cannot understand what meaning can be assigned to the distance of the sun from Sirius if the very nature of space depends upon casual intervening objects which we know nothing about. Unless we start with some knowledge of a systematically related structure of space-time we are dependent upon the contingent relations of bodies which we have not examined and cannot prejudge.

Furthermore, how time is to be got from the relations of permanent bodies completely puzzles me. And yet the moderns assimilate time with space. I have never seen even the beginning of an explanation of the meaning of the usual phraseology.

I have already reiterated, that measurement presupposes a structure yielding definite stretches which, in some sense inherent in the structure, match each other; and I have explained the type of structure which is formed by our space-time.

The essence of this structure is that it is stratified in many different ways by different time-systems. This is a very peculiar idea which is the product of the speculations of the last fifteen years or so. We owe the whole conception notably to Einstein. I do not agree with his way of handling his discovery. But I have no doubt as to its general correctness. It is at first sight somewhat of a shock to think that other beings may slice nature into time-sections in a different way to what we do. In fact we have differences even among ourselves which luckily are quite imperceptible. However if we allow this possibility we not only explain many modern delicate experiments, but we also obtain explanations of what we mean by the spatial extension in three dimensions, and by planes and straight lines, and parallels and right-angles. We also obtain a definite meaning for the matching which is the basis of our congruence. The explanation is too sweeping to be put aside. Our whole geometry is merely the expression of the ways in which different events are implicated in different time-systems.

I have also hitherto omitted to point out that all order in space is merely the expression of order in time. For a series of parallel planes

in the space of our time is merely the series of intersections with a series of moments of another time-system. Thus the order of the parallel planes is merely the time-order of the moments of this other system.

I must stop now. We started from the simplest idea which meets every child at the beginning of his or her schooldays. I mean the idea of equality.

We asked what it meant. We have then been led on and on, till we have found ourselves plunged in the abstruse modern speculations concerning the character of the Universe. They are not really very difficult. I call them abstruse because they deal with questions which we do not ordinarily think about. It is therefore a strain on our imaginations to follow the line of thought. But when we have once allowed the possibility of different meanings for time in nature, the argument is a straightforward deduction of the consequences.

CHAPTER IV *SOME PRINCIPLES OF PHYSICAL SCIENCE*

It is my ambition in this lecture to discuss some general principles of mathematical physics, and to illustrate them by their application to the problem of the gravitational field. In a sense such a discussion should form the first chapter of the science, but it is that first chapter which is studied last.

The Apparent World. It would be easy to quote an imposing array of authorities, almost a consensus of authorities, in support of the thesis that the subject matter of physical science is composed of things observed by the senses. Such things are sights, sounds, touches, bodily feelings, shapes, distances, and their mutual relations. I will call the whole assemblage of them the 'apparent world.' Natural science is therefore the study of the interconnections of the things forming the apparent world.

This profession of the motive of science seems however in sharp contradiction to its actual achievement. The molecular theory, the wave theory of light, and finally the electromagnetic theory of things in general have, as it seems, set up for scientific investigation a society of entities, such as ether, molecules, and electrons, which are intrinsically incapable of direct observation. When Sir Ernest Rutherford at Cambridge

knocks a molecule to pieces, he does not see a molecule or an electron. What he observes is a flash of light. There is at most a parallelism between his observation and the conjectural molecular catastrophe.

I suggest to you that, unless we are careful in our formulation of principles, the outcome of this train of thought is apt to be unsatisfactory and very misleading to scientific imagination. The apparent world becomes an individual psychological reaction to the stimulus of an entirely disparate interplay of electrons and ether. The whole of it is in the same boat. There is no principle by which we can assign for some of it any independence of individual psychology superior to that of the remainder.

On this theory we must entirely separate psychological time, space, external perceptions, and bodily feelings from the scientific world of molecular interaction. This strange world of science dwells apart like the gods of Epicurus, except that it has the peculiar property of inducing our minds to play upon us the familiar antics of our senses.

If we are to avoid this unfortunate bifurcation, we must construe our knowledge of the apparent world as being an individual experience of something which is more than personal. Nature is thus a totality including individual experiences, so that we must reject the distinction between nature as it really is and experiences of it which are purely psychological. Our experiences of the apparent world are nature itself.

Two-fold Cognisance. We have a two-fold cognisance of nature, and I will name the two factors of this experience 'cognisance by adjective' and 'cognisance by relatedness.'

Think of yourself as saying, 'There is a red patch.' You are affirming redness of something, and you are primarily conscious of that something because of its redness. In other words, the redness exhibits to you the something which is red. This is cognisance by adjective, red being the adjective. But your experience has gone further than mere cognisance by adjective. Your knowledge is not merely of something which is red. The patch is *there* and it endures while you are observing it. Thus you are cognisant of it as having spatio-temporal position, and by this we mean a certain type of relatedness to the rest of nature which is thereby involved in our particular experience. This knowledge of nature arising from its interconnectedness by spatio-temporal relations is cognisance by relatedness.

For example, the physiological account of the function of the brain as determining the conditions of external perception presupposes that

the events of the brain signify the totality of contemporaneous space. Again the disclosure of space behind the looking-glass as qualified by images situated in it exhibits the fact that the events in front of the glass are significant of contemporaneous space behind it. Also we know that there is space inside the closed cupboard.

Nature is an abstraction from something more concrete than itself which must also include imagination, thought, and emotion. This abstraction is characterised by the systematic coherency of its interconnections disclosed in cognisance by relatedness. Thus the substances of nature which have the cognised adjectives as their qualities are also the things in nature connected by the cognised relatedness. Nature is delimited as the field of this closed system of related things. Accordingly the ultimate facts of nature are events, and the essence of cognisance by relatedness is the ability to specify the event by time and by place. Dreams are ruled out by their inability to pass this test.

But an event can be specified in this way without its being the subject of direct cognisance by adjective. For example we can exactly specify a time and a place on the further surface of the moon, but we should very much like to know what is happening there. There is however a certain fullness in the dual cognisance both by adjective and by relatedness. I will use the term 'perception' for this full experience.

Mere cognisance by relatedness is essentially knowledge of an event merely by its spatio-temporal relations to other events which are perceived and thus form a framework of what is fully experienced. In this sense there is no cognisance by relatedness without perception.

It is not the case that the analysis of the adjectives of appearance attached to the events within any limited field of nature carries with it any certain knowledge of adjectives attached to other events in the rest of nature, or indeed of other such adjectives attached to those same events. I will refer to this fact by the phrase, the contingency of appearance.

On the other hand, though the character of time and space is not in any sense *a priori*, the essential relatedness of any perceived field of events to all other events requires that this relatedness of all events should conform to the ascertained disclosure derived from the limited field. For we can only know that distant events are spatio-temporally connected with the events immediately perceived by knowing what these relations are. In other words, these relations must possess a systematic uniformity in order that we may know of nature as extending beyond

isolated cases subjected to the direct examination of individual perception. I will refer to this fact by the phrase, the uniform significance of events.

Thus the constitutive character of nature is expressed by 'the contingency of appearance' and 'the uniform significance of events.' These laws express characters of nature disclosed respectively in cognisance by adjective and cognisance by relatedness. This doctrine leads to the rejection of Einstein's interpretation of his formulae, as expressing a casual heterogeneity of spatio-temporal warping, dependent upon contingent adjectives.

The case of the yard-measure illustrates my meaning. It is a contingent adjective of the events where it is situated. Its spatio-temporal properties are entirely derived from the events which it qualifies. For example, its use depends on the recognition of simultaneity, so that we shall not observe its two ends at widely different times. But simultaneity concerns events. Also the mere self-identity of the yard-measure does not suffice for its use, since we also admit the continued identity of objects which shrink or expand. The yard-measure is merely a device for making evident obscure relations between those events in which it appears.

If congruence merely meant relations between contingent adjectives of appearance, there would be no measurement of spatial distance or of temporal lapse without knowledge of actual intervening appearances, and no meaning for such distance in the absence of these adjectives. For example, the 'distance of the star Sirius' would be a phrase without meaning.

You will have observed that in this doctrine of cognisance by relatedness I am merely taking the old belief that we know of unbounded time and of unbounded space and am adapting it to my inversion which gives the supremacy to events and reduces time and space to mere relations between them.

The Doctrine of Time. It follows from my refusal to bifurcate nature into individual experience and external cause that we must reject the distinction between psychological time which is personal and impersonal time as it is in nature. Two conclusions follow, of which the one is conservative, and indeed almost reactionary, and the other is paradoxical.

The conservative conclusion is that in cognisance by relatedness the apparent world is disclosed as stratified into a succession of strata which

are subordinate totalities of immediate experience. Each short duration of time is merely a total slab of nature disclosed as a totality in cognisance by relatedness, and for any individual experience partially disclosed in cognisance by adjective. There can be no other meaning for time, if we admit the position from which my argument has started. I will state the doctrine in this way, Time is a stratification of nature. Adherence to this doctrine is today the mark of a reactionary. I accept the term with the qualification that it is reaction to the admission of obvious fact.

We now pass to the other conclusion which is paradoxical. The assumption of the uniqueness of the temporal stratification of nature has slipped into human thought. Certainly in each individual experience such uniqueness must be granted. But confessedly each individual experience is partial, and we cannot safely reason from partial experience to the limitation of the variety of nature. Accordingly the uniqueness of time succession for each of us does not guarantee its consistency for all.

At this point I put by urgent metaphysical questions concerning any supposed distinction between past, present, and future as to the character of their existence. Also I need not recall to your minds the reasons, based upon refined observations, for assuming the existence in nature of alternative time-systems entailing alternative systems of stratification.

I think that no one can study the evidence in its detail without becoming convinced that we are in the presence of one of the most profound reorganisations of scientific and philosophic thought. But so many considerations are raised, so diverse in character, that we are not justified in accepting blindfold the formulation of principles which guided Einstein to his formulae.

You will have observed that for reasons which I have briefly indicated, I maintain the old-fashioned belief in the fundamental character of simultaneity. But I adapt it to the novel outlook by the qualification that the meaning of simultaneity may be different in different individual experiences. Furthermore, since I start from the principle that what is apparent in individual experience is a fact of nature, it follows that there are in nature alternative systems of stratification involving different meanings for time and different meanings for space. Accordingly two events which may be simultaneous in one instantaneous space for one mode of stratification may not be simultaneous in an alternative mode.

Time and Space. The homogeneity of time with space arises from their

common share in the more fundamental quality of extension which is a quality belonging exclusively to events. By extension I mean that quality in virtue of which one event may be part of another or two events may have a common part. Nature is a continuum of events so that any two events are both parts of some larger event.

The heterogeneity of time from space arises from the difference in the character of passage in time from that of passage in space. Passage is the same as significance, and by significance I mean that quality of an event which arises from its spatio-temporal relationships to other events.

For the sake of simplicity I will speak of events whose dimensions are ideally restricted. I will call them 'event-particles.' Also we may conceive of an event restricted except in one dimension. Such an event may be termed a route or path, where I am now thinking of a route of transition through the continuum of nature. A route may evidently be also conceived as a linear chain of event-particles. But its essential unity is thereby lost. A 'spatial' route is a route which lies entirely in one instantaneous space. A 'historical' route is such that no two of its event-particles are simultaneous according to any time-system. Along such a route there is a definite antecedence and subsequence in time which is independent of alternative time-systems.

Thus the distinction of time from space, which I have just asserted, consists in the fact that passage along a spatial route has a different character from passage along a historical route. For proof of this fact think of a spatial route which has a material particle situated in each of its event-particles. We pronounce at once that all these material particles are different, because no material particle can be in two places at the same time. But if a historical route is in like case and the material particles be of like character even with some differences, we equally pronounce them to be the same material particle at successive stages of its existence. This difference of judgment can only arise from the distinction in the characters of spatial and temporal passage.

It only strengthens this argument when we remember that the events are the ultimate substance of nature and that the apparent material particle is an adjective of appearance which qualifies them. For the unique type of individuality possessed by the emergence of the same adjective throughout the historical route must be due to the special peculiarity of the route. I will recur to this question later when I define adjectival particles.

Time-Systems. According to the view which I am urging on you a moment of time is to be identified with an instantaneous spread of the apparent world. The relations of interconnection within this moment form a momentary three-dimensional space. Such a space is an abstraction from the full-bloodedness of a moment of time which includes all that is apparent in that space. A time-system is a sequence of non-intersecting moments including all nature forwards and backwards. I call the moments of such a consistent system 'parallel,' because all parallelism is derived from their mutual relations and from their intersections with the parallel moments of other time-systems.

I am also assuming on rather slight evidence that moments of different time-systems always intersect. This hypothesis is the simplest and I know of no phenomena that would be explained by its denial. The result is to introduce the peculiar properties of Euclidean parallelism.

One advantage of the admission of alternative time-systems is that they afford explanations of the notion of position and of the notion of evenly lying loci, such as planes and straight lines. However, I will not in this lecture enter into a detailed examination of the origins of geometry.

Permanent Space. The momentary spaces of a time-system are matters of direct observation, at least when we construe momentary in an approximate sense. They must be discriminated from the permanent space of that time-system.

Rest and motion are ultimate data of observation, and permanent space is the way of expressing the connections of these data. The ultimate elements of permanent space are therefore somewhat elaborate. It will be sufficient for my immediate purpose in this lecture to exhibit the meaning to be ascribed to a point of the permanent space of a time-system.

Consider observations wedded to a single temporal mode of stratification. Some apparent bodies will be observed to be in motion and others at rest. The historical route forming the successive situations of an apparent particle at rest for such an observer is a point in the permanent space which corresponds to that time-system. For an observer who is wedded to another time-system the same apparent particle will be moving with uniform velocity. Accordingly the point of the space of the former time-system cannot be a point of the space of the latter time-system, since to be at rest occupying one point in the space of one time-

system is to be moving through a succession of points in the space of another time-system. A permanent point is thus highly complex and only serves for one particular specification of the meaning of space and time. Each event-particle will occur at one point in each permanent space, and is thus the vertex of a pencil of points, one point for each time-system.

Each point intersects any moment, of whatever time-system, in just one event-particle. There is thus a point-wise correlation between the event-particles of any momentary space and the points of the permanent space of any time-system. This correlation explains the naturalness with which observation of momentary spaces is expressed in terms of permanent space so as to gain the facile representation of the phenomena of rest and motion, which can have no existence for a single momentary space.

This general theory of the grounds in nature for geometry and time is consistent with a rigid relativity whereby space and time are simply expressions for a certain observed ordering of events. Also it is essential to note that the spatial relations between apparent bodies only arise mediately through their implication in events. It is essential to adopt this view if we are to admit any assimilation of space and time.

The Physical Field. We now pass to the consideration of the status of the physical field of natural science. The scope of the contingency of appearance is limited, and the conditions of limitation are what we term the laws of nature.

They are expressed by assuming that the apparent adjectives of the past indicate a certain distribution of character throughout events extending from the past into the future. It is further assumed that this hypothetical distribution of character in its turn expresses the possibilities of adjectives of appearance attachable to the future events. Thus the regulation of future adjectives of appearance by past adjectives of appearance is expressed by this intermediate distribution of character, indicated by the past and indicating the future.

I call this intermediate distribution of character the 'physical field.' The true expression of the physical field is always to some extent a matter of conjecture. The only guarantee for correctness is the pragmatic test that the theory works.

The physical field is not the cause of perception nor is it the object perceived. The search for a cause of perception raises a problem which

is probably meaningless and certainly insoluble. The physical field is merely that character of nature which expresses the relatedness between the apparent adjectives of the past and the apparent adjectives of the future. It therefore shares in the contingency of appearance, and accordingly cannot affect spatio-temporal relations.

Atomicity. Luckily the physical field is atomic, so far as concerns our approximate measurements. By this I mean that we can discriminate in the four-dimensional continuum certain regions or events, such that each exhibits a physical character which is entirely independent of the physical characters of other events or of the other physical characters of that event. This physical character requires the whole region for its complete exposition. Thus atomicity implies two properties, one is the breakdown of relativity in that the atomic character is independent of the physical characters pervading the rest of nature, and the other is that we cannot completely exhibit this character without the whole corresponding region.

This physical atomic character is the only case in which the Aristotelian idea of an attribute of a substance holds without grave qualification, at least so far as the realm of nature is concerned. Furthermore, atomicity is a property which is capable of more or less complete realisation. Failure to attain complete atomicity is illustrated when one aspect of the physical field modifies another aspect of it, for example, when the physical field of mass modifies that of electro-magnetism.

Observe that the practical atomicity of the physical and apparent characters is essential for the intelligibility of the apparent world to a finite mind with only partial perception. Without atomicity we could not isolate our problems; every statement would require a detailed expression of all the facts of nature. It has always been a reproach to those philosophers who emphasize the systematic relatedness of reality that they make truth impossible for us by requiring a knowledge of all as a condition for a knowledge of any. In the account of nature which I have just given you this objection is met in two ways: In so far as nature is systematically related, it is a system of uniform relatedness; and in the second place, intelligibility is preserved amid the contingency of appearance by the breakdown of relatedness which is involved in atomicity.

This breakdown of relatedness in the expression of the laws of nature is reflected into observation by our perception of material

objects. Such an object is more than its colour, is more than its touch, and is more than our feeling of its resistance to push. The object, taken throughout its history, is a permanent factor conditioning adjectives of appearance, and it is a factor which is largely independent of its relatedness to other contingent facts. It is the endeavour to make precise this aspect of a perceived material object which has led to the atomicity of modern science.

Thus it is not true to say, without qualification, that the physical field is not perceived. We do recognise permanences in the relatedness of things sensed, permanences which are largely disconnected. The physical field is the endeavour to express precisely these perceived permanences as atomic characters of events.

Adjectival Particles. The discussion of these recognised permanences is reduced to an ideal simplicity by the introduction of adjectival particles, by which I mean the ideally small perceived bodies and the elementary physical particles.

I have already stated that an adjectival particle receives its enduring individuality from the individuality of its historical route. Let me now give a more precise statement of my meaning: An 'adjectival particle' is the adjective attached to the separate event-particles of a historical route by virtue of the fact that some one and the same adjective attaches to *every* stretch of the route. It is the outcome of the transference to the individual event-particles of a common property of all the stretches.

Accordingly the unique individuality of the particle is nothing else than the fusion of the continued sameness of the adjective with the concrete individuality of the historical route. We must not think of an adjectival particle as moving through its route. We will say that it 'pervades' its route, and that it is 'situated' at each event-particle of the route, and that it 'moves' in an orbit in each permanent space.

It follows from this conception of the meaning of an adjectival particle that the expression of its properties should require the consideration of stretches of its route. In order, even now, to attain ideal simplicity we proceed to the limit of making all such stretches infinitesimally small. A stretch of a historical route, as thus employed in the process of proceeding to a limit, will be called a 'kinematic element.' A kinematic element is equivalent to both the position and the velocity of an adjectival particle in any permanent space at any time.

Mass-Particles. A mass-particle is an adjectival particle. It follows that for some limited purposes we can treat it as being situated in an

event-particle, but that for the final purpose of enunciating the laws of nature we must conceive it as pervading a stretch of its historical route.

Consider [cf. figure, p. 317] first the former conception of a mass-particle m as situated at an event-particle which we will call P. The physical field due to m at P has to stretch away into the future. It is to be a limited atomic field with a foot in two camps, for it represents the property of the future as embodied in the past. It may therefore, so far as it is completely atomic, be expected to consist of that region within the future from P which has peculiar affinities with the region co-present with P.

Now what I call the kinematic future from P is the region traversed by the pencil of permanent points which has P as vertex, considering only the portions of those points which stream into the future from P. It will be remembered that there is one such point for each time-system. Again the region co-present with P is the region reached by the moments containing P. It will be remembered that each moment is an instantaneous three-dimensional space, and that there is one such moment for each time-system. Both these regions, the kinematic future from P and the region co-present with P, are four-dimensional. The ordered geometry of the four-dimensional continuum shows that the boundary region which separates the two is a three-dimensional region which belongs to neither. This three-dimensional region will be called the 'causal future' from P. It has all the properties that we want for an atomic region completely defined by P and for its delimitation not dependent upon any contingent characters of the rest of nature.

The atomic physical field of the mass-particle at P is P's causal future together with P itself. We will call P the origin of the field. The physical character of this field as a whole is what is meant by the mass-particle at P. This is merely Faraday's conception of the tubes of force as constituting the physical particle, with the modification that the tubes in the act of streaming through space also stream through time. Conceived under the guise of time and permanent space the mass-particle is a transmission of physical character along its lines of force with a definite finite velocity.

Metrical Formulae. A few mathematical formulae are now necessary for my argument. The assumption, adopted as the simplest representation of observed facts, that the permanent space of each time-system is Euclidean, leads to the formulae of the special theory of relativity. There is however this difference that the critical velocity c has no

reference to light, and merely expresses the fact that a lapse of time and a stretch of spatial route can be congruent to each other.

Define the quantities

$$\left.\begin{array}{r} \omega_\mu, [\mu = 1, 2, 3, 4] \\ \omega_\mu{}^2 = 1, [\mu = 1, 2, 3] \\ \omega_4{}^2 = -c^2 \end{array}\right\} \quad \ldots\ldots\ldots (1).$$

by

Let a rectangular Cartesian system of coordinates in the permanent space of the 'x' time-system be (x_1, x_2, x_3) and let the lapse of x-time since zero time be x_4. Thus (x_1, x_2, x_3, x_4) are the four coordinates of an event-particle, which we will name X. Also in the 'y' time-system, we denote analogously a permanent point by the Cartesian coordinates (y_1, y_2, y_3) and a lapse of y-time by y_4. Let (y_1, y_2, y_3, y_4) and (x_1, x_2, x_3, x_4) denote the same event-particle.

Then [cf. *The Principles of Natural Knowledge*, Ch. XIII] the relations between the two systems of coordinates, the 'x' system and the 'y' system, are of the form

$$\omega_\mu (y_\mu - b_\mu) = \sum_\alpha l_{\mu\alpha}\omega_\alpha x_\alpha, [\mu = 1, 2, 3, 4] \quad \ldots\ldots (2),$$

where the symbol $\sum_\alpha$ means summation for $\alpha = 1, 2, 3, 4$ successively, and the l's are constants satisfying the conditions

$$\left.\begin{array}{r} \sum_\mu l_{\mu\alpha}l_{\mu\beta} = 0, [\alpha \neq \beta] \\ = 1, [\alpha = \beta] \end{array}\right\} \quad \ldots\ldots\ldots (3).$$

These conditions entail analogous formulae for the converse transformation from 'y' to 'x.'

It follows that, if the coordinates of another event-particle, named P, be (p_1, p_2, p_3, p_4) in the 'x' system and (q_1, q_2, q_3, q_4) in the 'y' system,

$$-\sum_\alpha \omega_\alpha{}^2(x_\alpha - p_\alpha)^2 = -\sum_\mu \omega_\mu{}^2(y_\mu - q_\mu)^2.$$

Let $r_{(x)}$ and $r_{(y)}$ be respectively the x-distance and the y-distance between X and P. Then this invariant for X and P can be expressed indifferently either by

$$\left.\begin{array}{r} c^2(x_4 - p_4)^2 - r_{(x)}{}^2 \\ c^2(y_4 - q_4)^2 - r_{(y)}{}^2 \end{array}\right\} \quad \ldots\ldots\ldots (4).$$

or by

Then

(i) X and P are co-present, if

$$c^2(x_4 - p_4)^2 - r_{(x)}{}^2 < 0,$$

(ii) P is kinematically antecedent to X, if

$$x_4 > p_4, \text{ and } c^2(x_4 - p_4)^2 - r_{(x)}^2 > 0,$$

(iii) X lies in the causal future from P, if

$$c(x_4 - p_4) = r_{(x)}.$$

Routes of Adjectival Particles. Let the mass-particle M be situated at X and the mass-particle m be situated at P, and let X' and P' be event-particles respectively neighbouring to X and P on the historical routes of M and m in the four-dimensional continuum of nature. Let their coordinates be respectively

$$(x_\mu + dx_\mu, \ldots) \text{ and } (p_\mu + dp_\mu, \ldots), [\mu = 1, 2, 3, 4].$$

These are accordingly infinitesimal invariants dG_M^2 and dG_m^2, respectively expressing a spatio-temporal property of the kinematic elements XX' and PP'. This property depends on the existence of the whole bundle of diverse time-systems without special emphasis on any one of them. These invariants [cf. equation (4)] are expressed by

$$\left.\begin{aligned} dG_M^2 &= -\sum_a \omega_a^2 dx_a^2 \\ dG_m^2 &= -\sum_a \omega_a^2 dp_a^2 \end{aligned}\right\} \quad \ldots\ldots\ldots (5).$$

Let the route of M be expressed by assuming x_1, x_2, x_3 to be appropriate functions of x_4, and the route of m by assuming p_1, p_2, p_3 to be appropriate functions of p_4. Thus, always in reference to these assumptions, we write

$$\dot{x}_\mu = \frac{dx_\mu}{dx_4}, \text{ and } \dot{p}_\mu = \frac{dp_\mu}{dp_4}.$$

Also we put

$$\left.\begin{aligned} v_m^2 &= \dot{p}_1^2 + \dot{p}_2^2 + \dot{p}_3^2 \\ v_M^2 &= \dot{x}_1^2 + \dot{x}_2^2 + \dot{x}_3^2 \end{aligned}\right\} \quad \ldots\ldots\ldots (6)$$

and

$$\left.\begin{aligned} \Omega_m &= \left\{1 - \frac{v_m^2}{c^2}\right\}^{-\frac{1}{2}} \\ \Omega_M &= \left\{1 - \frac{v_M^2}{c^2}\right\}^{-\frac{1}{2}} \end{aligned}\right\} \quad \ldots\ldots\ldots\ldots (7)$$

and

$$\xi_m = c^{-1}\{(x_1 - p_1)\dot{p}_1 + (x_2 - p_2)\dot{p}_2 + (x_3 - p_3)\dot{p}_3\} \ldots (8).$$

Impetus. In order to exhibit the character of the physical field due to a mass-particle we must consider it as pervading a kinematic element, which has the advantage over an event-particle of retaining the quality of historic passage. A loss of spatial dimensions is comparatively immaterial, though it probably represents a simplification beyond anything which obtains in nature.

In expressing the physical field due to m we must therefore consider the kinematic element PP' of its route. Also we must take any arbitrary element XX', and consider how its qualifications as a possible kinematic element of the route of M are affected by the fact that m pervades the element PP'.

Each kinematic element, such as XX', having X as initial starting-point will have certain physical characters. The assemblage of quantities defining these physical characters for this pencil of elements constitutes the physical field at X. The two such characters which we need consider, as qualifying XX' for pervasion by M, are its potential mass impetus and its potential electromagnetic impetus.

The potential mass impetus along XX' will be written $\sqrt{dJ^2}$, and the potential electromagnetic impetus will be written dF. If the mass of the particle M be also denoted by M, and its electric charge, in electrostatic units, by E, then the realised mass impetus due to pervasion of XX' by M will be

$$M\sqrt{dJ^2},$$

and the realised electromagnetic impetus, due to the same pervasion, will be

$$c^{-1}EdF.$$

The total impetus along XX' realised by its pervasion by M is

$$dI = M\sqrt{dJ^2} + c^{-1}EdF \quad \ldots\ldots\ldots (9).$$

Summing along the route of M between the assigned event-particles A to B, we obtain the realised impetus along this route which is symbolised by

$$\int_A^B \{M\sqrt{dJ^2} + c^{-1}EdF\}.$$

If this total impetus is to be finite, it is evident that $\sqrt{dJ^2}$ and dF must be homogeneous functions of du_1, du_2, du_3, du_4 of the first degree,

where (u_1, u_2, u_3, u_4) are any generalised coordinates of X. Thus, guided empirically by the ascertained character of dynamical equations and of the electromagnetic field, we can assume

$$\left.\begin{aligned} dJ^2 &= \sum_{\mu}\sum_{\nu} J^{(u)}_{\mu\nu}\, du_\mu du_\nu \\ dF &= \sum_{\mu} F^{(u)}_{\mu}\, du_\mu \end{aligned}\right\} \quad \ldots\ldots\ldots (10).$$

Thus $\|J^{(u)}_{\mu\nu}\|$ is a symmetric covariant tensor of the second order and $\|F^{(u)}_{\mu}\|$ is a covariant tensor of the first order. The elements of these tensors are functions of the coordinates of X, that is, of (u_1, u_2, u_3, u_4). These tensors define the physical field at X so far as inertial and electromagnetic properties are concerned.

Hence, writing as above

$$\dot{u}_\mu = \frac{du_\mu}{du_4}, \; [\mu = 1, 2, 3, 4]$$

for differentiation along the route of M, $\dfrac{dI}{du_4}$ is a function of $\dot{u}_1, \dot{u}_2, \dot{u}_3$, and of u_1, u_2, u_3, u_4. We now assume that the actual route of M satisfies the condition that the realised impetus is stationary between A and B for small variations of route. We thus obtain the equations of motion

$$\frac{d}{du_4}\frac{\partial}{\partial \dot{u}_\mu}\frac{dI}{du_4} - \frac{\partial}{\partial u_\mu}\frac{dI}{du_4} = 0, \; [\mu = 1, 2, 3] \; . \; . \; . \; . \; (11).$$

Expression for the Gravitational Field. I will now confine myself to the proper determination of dJ^2, as affected by the existence of other mass-particles m, m', etc., in other routes. In expressing the conditions restraining the contingency of appearance it is necessary that we have recourse to that aspect of nature which is independent of this contingency. The only such aspect is that arising from spatio-temporal properties. Also $dG_M{}^2$ and $dG_m{}^2$ are the invariants expressing the quantitative aspect of the historical passage of the elements XX' and PP'.

Again in considering the physical character of XX' as affected by m in its route, we must select that kinematic element PP' of m's route which is causally correlated with XX'. By this I mean that PP' has a point-wise correlation with XX' such that X is in the causal future from P and X' is in the causal future from P'. With this correlation the

physical character of PP' is already determined when XX' occurs.

This assumption of causal correlation is mathematically expressed by the relation

$$x_4 - p_4 = r_{(x)}/c \quad \ldots\ldots\ldots\ldots (12)$$

between corresponding event-particles on XX' and PP'.

The main empirical facts of gravitation are expressed by the assumption that

$$dJ^2 = dG_M{}^2 - \frac{2}{c^2}\sum_m \Psi_m \, dG_m{}^2 \ldots\ldots (13),$$

where $\sum_m$ means the summation for all mass-particles such as m in kinematic elements such as PP', causally correlated to XX', and Ψ_m expresses the gravitational law of fading intensity. The factor $2/c^2$ is inserted so that, when the main intensity is empirically adjusted to give the main inverse square law of gravitation, Ψ_m may be the analogue of the familiar gravitational potential at X due to m. It is easy to prove [cf. Part III] that, apart from any assumption of causal correlation between X and P,

$$\Omega_m\{c(x_4 - p_4) - \xi_m\}$$

has an invariant value for all sets of rectangular Cartesian coordinates in all time-systems. Also with the causal correlation between PP' and XX' which we are assuming, this invariant expression reduces to

$$\Omega_m\{r_{(x)} - \xi_m\}.$$

Accordingly, guided by our knowledge of the Newtonian law of gravitation, we assume

$$\Psi_m = \frac{\gamma m}{\Omega_m\{r_{(x)} - \xi_m\}} \quad \ldots\ldots\ldots (14),$$

where γ is the familiar constant of gravitation so as to produce the scale of intensity of the main inverse square Newtonian term.

If we write

$$\Psi = \sum_m \frac{\gamma m}{\Omega_m\{r_{(x)} - \xi_m\}} \quad \ldots\ldots\ldots (15),$$

then in an empty region Ψ satisfies

$$\nabla^2_{(x)}\Psi - \frac{1}{c^2}\frac{\partial^2 \Psi}{\partial x_4{}^2} = 0 \quad \ldots\ldots\ldots (16).$$

We might, if we had preferred to do so, have started from the differential equation as the only invariant form of linear differential equation of the second order, and then deduced the above solution for Ψ_m as the only invariant solution for a single point-wise discontinuity. The procedure of thought which I have adopted seems to me to be better suited to throw into relief the fundamental ideas concerning nature.

Comparison with Einstein's Law. In the formula

$$dJ^2 = dG_M{}^2 - \frac{2}{c^2} \sum_m \frac{\gamma m}{\Omega_m(r_{(x)} - \xi_m)} dG_m{}^2 \quad . \quad . \quad . \quad . \quad . \quad (17)$$

$\sqrt{dJ^2}$ corresponds to Einstein's proper time ds. By identifying the potential mass impetus of a kinematic element with a spatio-temporal measurement Einstein, in my opinion, leaves the whole antecedent theory of measurement in confusion, when it is confronted with the actual conditions of our perceptual knowledge. The potential impetus shares in the contingency of appearance. It therefore follows that measurement on his theory lacks systematic uniformity and requires a knowledge of the actual contingent physical field before it is possible. For example, we could not say how far the image of a luminous object lies behind a looking-glass without knowing what is actually behind that looking-glass.

The above formula, assumed for dJ^2, also differs from Einstein's. In his procedure the J's are conditioned by making them satisfy the contracted Riemann-Christoffel tensor equations. He obtains a solution of these equations for a single point-singularity under the assumption that the gravitational field is permanent for the coordinates adopted so that no elements of the array $\|J_{\mu\nu}\|$ are functions of the time in the system of coordinates adopted. This limitation rules out any application of this solution to cases like that of the moon's motion, where the sun and earth evidently cannot both produce gravitational fields permanent for the same system of coordinates. My formula, given above, applies generally to all such cases. It is a matter for investigation whether the small terms depending on the motions thereby introduced into the gravitational formulae produce effects which are verified in observation as recorded in the discrepancies of the moon's tables. I have traced some theoretical effects of these terms of the order of magnitude of one or two seconds of arc with periods of the order of a month or a year,

but I have not yet succeeded in hitting on a term of a period long enough to aggregate an observable effect, having regard to the state of the moon's tables. We want periods of about 250 years.

If the above formula gives results which are discrepant with observation, it would be quite possible with my general theory of nature to adopt Einstein's formula, based upon his differential equations, for the determination of the gravitational field. They have however, as initial assumptions, the disadvantage of being difficult to solve and not linear. But it is purely a matter for experiment to decide which formula gives the small corrections which are observed in nature. So far as matters stand at present both formulae give the motion of Mercury's perihelion, my formula gives a possible shift of the spectral lines dependent upon the structure of the molecule and on the interplay of the gravitational and electromagnetic fields, and lastly, assuming a well-known modification of Maxwell's equations giving such an interplay, the famous eclipse results follow.*

Alternative Laws of Gravitation. Perhaps neither of the above formulae will survive further tests of other delicate observations. In this event we are not at the end of our resources. There are, in addition to Einstein's, yet two other sets of tensor differential equations which on the theory of nature explained in this lecture satisfy all the general requirements. These requirements are, (i) to have no arbitrary reference to any one particular time-system, and (ii) to give the Newtonian term of the inverse square law, and (iii) to yield the small corrections which explain various residual results which cannot be deduced as effects of the main Newtonian law.

The possibility of other such laws, expressed in sets of differential equations other than Einstein's, arises from the fact that on my theory there is a relevant fact of nature which is absent on Einstein's theory. This fact is the whole bundle of alternative time stratifications arising from the uniform significance of events. It is expressed, without emphasis on any one such time-system, by the Galilean tensor $\|G_{\mu\nu}^{(u)}\|$. This tensor is defined by the property that, when expressed in terms of rectangular Cartesian coordinates (x_1, x_2, x_3, x_4) for any time-system 'x,'

$$\left.\begin{aligned} G_{\mu\nu}^{(x)} &= 0, [\mu \neq \nu] \\ G_{\mu\mu}^{(x)} &= -\omega_\mu{}^2, [\mu = 1, 2, 3, 4] \end{aligned}\right\} \quad \ldots\ldots \quad (18).$$

* In Part II the 'Limb Effect' and the doubling or trebling of the spectral lines are also deduced.

Thus we have on hand two tensors, the above Galilean tensor and the tensor of the gravitational field which is

$$\|J^{(x)}_{\mu\nu}\|.$$

In order to formulate the differential equations involving the gravitational laws we shall require the three-index symbols of the first and second types for both the tensors $\|J_{\mu\nu}\|$ and $\|G_{\mu\nu}\|$. They will be written*

$$J[\mu\nu, \lambda]^{(u)} \text{ and } G[\mu\nu, \lambda]^{(u)}$$

for the symbols of the first type, and

$$J\{\mu\nu, \lambda\}^{(u)} \text{ and } G\{\mu\nu, \lambda\}^{(u)}$$

for the symbols of the second type. Also the associate contravariant tensors are written $\|J^{\mu\nu}_{(u)}\|$ and $\|G^{\mu\nu}_{(u)}\|$, and the determinant $\|J^{(u)}_{\mu\nu}\|$ is symbolised by $J^{(u)}$.

(i) Einstein's Law is

$$\left.\begin{aligned} &\sum_{\rho}\left[\frac{\partial}{\partial u_\rho} J\{\mu\nu, \rho\}^{(u)} + J\{\mu\nu, \rho\}^{(u)} \frac{\partial}{\partial u_\rho} \log\{-J^{(u)}\}^{\frac{1}{2}}\right] \\ &- \sum_{\rho}\sum_{\sigma} J\{\mu\sigma, \rho\}^{(u)} J\{\nu\rho, \sigma\}^{(u)} - \frac{\partial^2}{\partial u_\mu \partial u_\nu} \log\{-J^{(u)}\}^{\frac{1}{2}} = 0, \\ &\qquad\qquad [\mu, \nu = 1, 2, 3, 4] \end{aligned}\right\} \quad . \quad (19).$$

The two other laws which involve differential equations depend upon making the proper substitutions for the mixed tensor

$$\|K^{\lambda}_{\mu\nu}\|$$

in the following tensor equations

$$\left.\begin{aligned} &\sum_{\rho}\left[\frac{\partial K^{\rho}_{\mu\nu}}{\partial u_\rho} + K^{\rho}_{\mu\nu} \frac{\partial}{\partial u_\rho} \log\{-G^{(u)}\}^{\frac{1}{2}}\right] - \sum_{\rho}\sum_{\sigma}[K^{\sigma}_{\rho\nu} G\{\mu\sigma, \rho\}^{(u)} \\ &+ K^{\sigma}_{\rho\mu} G\{\nu\sigma, \rho\}^{(u)}] = 0, [\mu, \nu = 1, 2, 3, 4] \end{aligned}\right\} \quad . \quad . \quad . \quad (20).$$

(ii) In this law the mixed tensor $\|K^{\lambda}_{\mu\nu}\|$ of the above equation is to stand for

$$\|\sum_{\alpha} G^{\lambda\alpha}_{(u)} J[\mu\nu, \alpha]^{(u)} - \sum_{\alpha}\sum_{\beta} G^{\lambda\alpha}_{(u)} J^{(u)}_{\alpha\beta} G\{\mu\nu, \beta\}^{(u)}\|.$$

(iii) In this law the mixed tensor $\|K^{\lambda}_{\mu\nu}\|$ of the equation above is to stand for

$$\|\sum_{\alpha} T^{\lambda\alpha}_{(u)} J[\mu\nu, \alpha]^{(u)} - \sum_{\alpha}\sum_{\beta} T^{\lambda\alpha}_{(u)} J^{(u)}_{\alpha\beta} G\{\mu\nu, \beta\}^{(u)}\|,$$

* Cf. Part II, Chapter v, equation (8), and Chapter vi, equation (13).

where $\|T^{\mu\nu}_{(u)}\|$ is some contravariant tensor arising from some quality of the electromagnetic field. This law is suited to express the interaction (if any) of the electromagnetic field on the gravitational field.

If the equations of laws (ii) and (iii) be referred to rectangular Cartesian coordinates, they become

$$\text{(ii)}\quad \sum_{\rho} \frac{1}{\omega_\rho{}^2} \frac{\partial}{\partial x_\rho} J[\mu\nu, \rho]^{(x)} = 0, [\mu, \nu = 1, 2, 3, 4] \quad . \quad . \quad . \quad . \quad . \quad . \quad (21),$$

and

$$\text{(iii)}\quad \sum_{\rho}\sum_{\sigma} \frac{\partial}{\partial x_\rho} T^{\rho\sigma}_{(x)} J[\mu\nu, \sigma]^{(x)} = 0, [\mu, \nu = 1, 2, 3, 4] \quad . \quad . \quad . \quad . \quad . \quad . \quad (22).$$

(iv) The fourth law has already been considered. It can be expressed in the integral form

$$dJ^2 = dG_M{}^2 - \frac{2}{c^2} \sum_{m} \frac{\gamma m}{\Omega_m(r_{(x)} - \xi_m)} dG_m{}^2 \quad . \quad . \quad . \quad . \quad (23),$$

where the kinematic element corresponding to $dG_m{}^2$ is causally correlated to that corresponding to $dG_M{}^2$.

According to this law the fundamental character of inertial properties is derived from their intimate connection with the abstract measure of uniform process in the spatio-temporal field. Thus $\sqrt{dG_M{}^2}$ and $\sqrt{dG_m{}^2}$ are these abstract measures of spatio-temporal process in the elements XX' and PP' of the tracks of M and m respectively. The inertial physical field modifies this abstract measure of process into the more concrete potential impetus $\sqrt{dJ^2}$, and full concreteness, so far as it is ascribable to nature, is obtained in the realised impetus $M\sqrt{dJ^2}$.

Rotation. In conclusion I will for one moment draw your attention to rotation. The effects of rotation are among the most widespread phenomena of the apparent world, exemplified in the most gigantic nebulae and in the minutest molecules. The most obvious fact about rotational effects are their apparent disconnections from outlying phenomena. Rotation is the stronghold of those who believe that in some sense there is an absolute space to provide a framework of dynamical axes. Newton cited it in support of this doctrine. The Einstein theory in explaining gravitation has made rotation an entire mystery. Is the earth's relation to the stars the reason why it bulges at the equator? Are we to understand that if there were a larger proportion of run-away stars, the earth's polar and equatorial axes would be equal, and that

the nebulae would lose their spiral form, and that the influence of the earth's rotation on meteorology would cease? Is it the influence of the stars which prevents the earth from falling into the sun? The theory of space and time given in this lecture, with its fundamental insistence on the bundle of time-systems with their permanent spaces, provides the necessary dynamical axes and thus accounts for these fundamental phenomena. I hold this fact to be a strong argument in its favour, based entirely on the direct results of experience.

Conclusion. The course of my argument has led me generally to couple my allusions to Einstein with some criticism. But that does not in any way represent my attitude towards him. My whole course of thought presupposes the magnificent stroke of genius by which Einstein and Minkowski assimilated time and space. It also presupposes the general method of seeking tensor or invariant relations as general expressions for the laws of the physical field, a method due to Einstein. But the worst homage we can pay to genius is to accept uncritically formulations of truths which we owe to it.

Science and the Modern World

Chapter I	The Origins of Modern Science	363
Chapter II	Mathematics As an Element in the History of Thought	380
Chapter III	The Century of Genius	397
Chapter IV	The Eighteenth Century	414
Chapter V	The Romantic Reaction	430
Chapter VI	The Nineteenth Century	449

SCIENCE AND THE MODERN WORLD

Science and the Modern World, nine chapters of which were the Lowell Institute Lectures in 1925, was originally published in 1925. It is perhaps that one of his books which has received the widest general attention, and has been considered as a landmark in the history of philosophy.

Included in this anthology are the first six chapters of Science and the Modern World, which may be said to be the historical section of the book, moving as it does from "The Origins of Modern Science" to "The Nineteenth Century."

The titles of the remaining chapters of the book are "Relativity," "The Quantum Theory," "Science and Philosophy," "Abstraction," "God," "Religion and Science," and "Requisites for Social Progress."

The reader will recall that in On Mathematical Concepts of the Material World Whitehead endeavored to give, among other things, a rigid mathematical account of the basic concept of nature shared by the orthodox philosophers of the seventeenth and eighteenth centuries and an equally precise account of an alternative concept. In the chapters which appear here he stresses rather his reasons for finding the concept held in the seventeenth and eighteenth centuries quite inadequate and for endeavoring to develop a new concept of nature, or cosmology, more in accord with the methods and findings of modern science.

CHAPTER I *THE ORIGINS OF MODERN SCIENCE*

The progress of civilisation is not wholly a uniform drift towards better things. It may perhaps wear this aspect if we map it on a scale which is large enough. But such broad views obscure the details on which rests our whole understanding of the process. New epochs emerge with comparative suddenness, if we have regard to the scores of thousands of years throughout which the complete history extends. Secluded races suddenly take their places in the main stream of events: technological discoveries transform the mechanism of human life: a primitive art quickly flowers into full satisfaction of some aesthetic craving: great religions in their crusading youth spread through the nations the peace of Heaven and the sword of the Lord.

The sixteenth century of our era saw the disruption of Western Christianity and the rise of modern science. It was an age of ferment. Nothing was settled, though much was opened—new worlds and new ideas. In science, Copernicus and Vesalius may be chosen as representative figures: they typify the new cosmology and the scientific emphasis on direct observation. Giordano Bruno was the martyr; though the cause for which he suffered was not that of science, but that of free imaginative speculation. His death in the year 1600 ushered in the first century of modern science in the strict sense of the term. In his execution there was an unconscious symbolism: for the subsequent tone of scientific thought has contained distrust of his type of general speculativeness. The Reformation, for all its importance, may be considered as a domestic affair of the European races. Even the Christianity of the East viewed it with profound disengagement. Furthermore, such disruptions are no new phenomena in the history of Christianity or of other religions. When we project this great revolution upon the whole history of the Christian Church, we cannot look upon it as introducing a new principle into human life. For good or for evil, it was a great transformation of religion; but it was not the coming of religion. It did not itself claim to be so. Reformers maintained that they were only restoring what had been forgotten.

It is quite otherwise with the rise of modern science. In every way it contrasts with the contemporary religious movement. The Reformation was a popular uprising, and for a century and a half drenched Europe in blood. The beginnings of the scientific movement were confined to a minority among the intellectual élite. In a generation which saw the Thirty Years' War and remembered Alva in the Netherlands, the worst that happened to men of science was that Galileo suffered an honourable detention and a mild reproof, before dying peacefully in his bed. The way in which the persecution of Galileo has been remembered is a tribute to the quiet commencement of the most intimate change in outlook which the human race had yet encountered. Since a babe was born in a manger, it may be doubted whether so great a thing has happened with so little stir.

The thesis which these lectures will illustrate is that this quiet growth of science has practically recoloured our mentality so that modes of thought which in former times were exceptional are now broadly spread through the educated world. This new colouring of ways of thought had been proceedingly slowly for many ages in the European peoples. At last it issued in the rapid development of science; and has thereby strengthened itself by its most obvious application. The new mentality is more important even than the new science and the new technology. It has altered the metaphysical presuppositions and the imaginative contents of our minds; so that now the old stimuli provoke a new response. Perhaps my metaphor of a new colour is too strong. What I mean is just that slightest change of tone which yet makes all the difference. This is exactly illustrated by a sentence from a published letter of that adorable genius, William James. When he was finishing his great treatise on the *Principles of Psychology,* he wrote to his brother Henry James, 'I have to forge every sentence in the teeth of irreducible and stubborn facts.'

This new tinge to modern minds is a vehement and passionate interest in the relation of general principles to irreducible and stubborn facts. All the world over and at all times there have been practical men, absorbed in 'irreducible and stubborn facts': all the world over and at all times there have been men of philosophic temperament who have been absorbed in the weaving of general principles. It is this union of passionate interest in the detailed facts

with equal devotion to abstract generalisation which forms the novelty in our present society. Previously it had appeared sporadically and as if by chance. This balance of mind has now become part of the tradition which infects cultivated thought. It is the salt which keeps life sweet. The main business of universities is to transmit this tradition as a widespread inheritance from generation to generation.

Another contrast which singles out science from among the European movements of the sixteenth and seventeenth centuries is its universality. Modern science was born in Europe, but its home is the whole world. In the last two centuries there has been a long and confused impact of Western modes upon the civilisation of Asia. The wise men of the East have been puzzling, and are puzzling, as to what may be the regulative secret of life which can be passed from West to East without the wanton destruction of their own inheritance which they so rightly prize. More and more it is becoming evident that what the West can most readily give to the East is its science and its scientific outlook. This is transferable from country to country, and from race to race, wherever there is a rational society.

In this course of lectures I shall not discuss the details of scientific discovery. My theme is the energising of a state of mind in the modern world, its broad generalisations, and its impact upon other spiritual forces. There are two ways of reading history, forwards and backwards. In the history of thought, we require both methods. A climate of opinion—to use the happy phrase of a seventeenth century writer—requires for its understanding the consideration of its antecedents and its issues. Accordingly in this lecture I shall consider some of the antecedents of our modern approach to the investigation of nature.

In the first place, there can be no living science unless there is a widespread instinctive conviction in the existence of an *Order of Things,* and, in particular, of an *Order of Nature.* I have used the word *instinctive* advisedly. It does not matter what men say in words, so long as their activities are controlled by settled instincts. The words may ultimately destroy the instincts. But until this has occurred, words do not count. This remark is important in respect to the history of scientific thought. For we shall find that since the time of Hume, the fashionable scientific philosophy has been such as to deny the rationality of science. This conclusion lies upon the surface of Hume's philosophy. Take, for example, the following

passage from Section IV of his *Inquiry Concerning Human Understanding:*

> 'In a word, then, every effect is a distinct event from its cause. It could not, therefore, be discovered in the cause; and the first invention or conception of it, *a priori,* must be entirely arbitrary.'

If the cause in itself discloses no information as to the effect, so that the first invention of it must be *entirely* arbitrary, it follows at once that science is impossible, except in the sense of establishing *entirely arbitrary* connections which are not warranted by anything intrinsic to the natures either of causes or effects. Some variant of Hume's philosophy has generally prevailed among men of science. But scientific faith has risen to the occasion, and has tacitly removed the philosophic mountain.

In view of this strange contradiction in scientific thought, it is of the first importance to consider the antecedents of a faith which is impervious to the demand for a consistent rationality. We have therefore to trace the rise of the instinctive faith that there is an Order of Nature which can be traced in every detached occurrence.

Of course we all share in this faith, and we therefore believe that the reason for the faith is our apprehension of its truth. But the formation of a general idea—such as the idea of the Order of Nature—and the grasp of its importance, and the observation of its exemplification in a variety of occasions are by no means the necessary consequences of the truth of the idea in question. Familiar things happen, and mankind does not bother about them. It requires a very unusual mind to undertake the analysis of the obvious. Accordingly I wish to consider the stages in which this analysis became explicit, and finally became unalterably impressed upon the educated minds of Western Europe.

Obviously, the main recurrences of life are too insistent to escape the notice of the least rational of humans; and even before the dawn of rationality, they have impressed themselves upon the instincts of animals. It is unnecessary to labour the point, that in broad outline certain general states of nature recur, and that our very natures have adapted themselves to such repetitions.

But there is a complementary fact which is equally true and equally obvious:—nothing ever really recurs in exact detail. No two days are identical, no two winters. What has gone, has gone forever.

Accordingly the practical philosophy of mankind has been to expect the broad recurrences, and to accept the details as emanating from the inscrutable womb of things beyond the ken of rationality. Men expected the sun to rise, but the wind bloweth where it listeth.

Certainly from the classical Greek civilisation onwards there have been men, and indeed groups of men, who have placed themselves beyond this acceptance of an ultimate irrationality. Such men have endeavoured to explain all phenomena as the outcome of an order of things which extends to every detail. Geniuses such as Aristotle, or Archimedes, or Roger Bacon, must have been endowed with the full scientific mentality, which instinctively holds that all things great and small are conceivable as exemplifications of general principles which reign throughout the natural order.

But until the close of the Middle Ages the general educated public did not feel that intimate conviction, and that detailed interest, in such an idea, so as to lead to an unceasing supply of men, with ability and opportunity adequate to maintain a coördinated search for the discovery of these hypothetical principles. Either people were doubtful about the existence of such principles, or were doubtful about any success in finding them, or took no interest in thinking about them, or were oblivious to their practical importance when found. For whatever reason, search was languid, if we have regard to the opportunities of a high civilisation and the length of time concerned. Why did the pace suddenly quicken in the sixteenth and seventeenth centuries? At the close of the Middle Ages a new mentality discloses itself. Invention stimulated thought, thought quickened physical speculation, Greek manuscripts disclosed what the ancients had discovered. Finally although in the year 1500 Europe knew less than Archimedes who died in the year 212 B.C., yet in the year 1700, Newton's *Principia* had been written and the world was well started on the modern epoch.

There have been great civilisations in which the peculiar balance of mind required for science has only fitfully appeared and has produced the feeblest result. For example, the more we know of Chinese art, of Chinese literature, and of the Chinese philosophy of life, the more we admire the heights to which that civilisation attained. For thousands of years, there have been in China acute and learned men patiently devoting their lives to study. Having regard to the span of time, and to the population concerned, China

forms the largest volume of civilisation which the world has seen. There is no reason to doubt the intrinsic capacity of individual Chinamen for the pursuit of science. And yet Chinese science is practically negligible. There is no reason to believe that China if left to itself would have ever produced any progress in science. The same may be said of India. Furthermore, if the Persians had enslaved the Greeks, there is no definite ground for belief that science would have flourished in Europe. The Romans showed no particular originality in that line. Even as it was, the Greeks, though they founded the movement, did not sustain it with the concentrated interest which modern Europe has shown. I am not alluding to the last few generations of the European peoples on both sides of the ocean; I mean the smaller Europe of the Reformation period, distracted as it was with wars and religious disputes. Consider the world of the eastern Mediterranean, from Sicily to western Asia, during the period of about 1400 years from the death of Archimedes [in 212 B.C.] to the irruption of the Tartars. There were wars and revolutions and large changes of religion: but nothing much worse than the wars of the sixteenth and seventeenth centuries throughout Europe. There was a great and wealthy civilisation, Pagan, Christian, Mahometan. In that period a great deal was added to science. But on the whole the progress was slow and wavering; and, except in mathematics, the men of the Renaissance practically started from the position which Archimedes had reached. There had been some progress in medicine and some progress in astronomy. But the total advance was very little compared to the marvellous success of the seventeenth century. For example, compare the progress of scientific knowledge from the year 1560, just before the births of Galileo and of Kepler, up to the year 1700, when Newton was in the height of his fame, with the progress in the ancient period, already mentioned, exactly ten times as long.

Nevertheless, Greece was the mother of Europe; and it is to Greece that we must look in order to find the origin of our modern ideas. We all know that on the eastern shores of the Mediterranean there was a very flourishing school of Ionian philosophers, deeply interested in theories concerning nature. Their ideas have been transmitted to us, enriched by the genius of Plato and Aristotle. But, with the exception of Aristotle, and it is a large exception, this school of thought had not attained to the complete scientific mentality. In

some ways, it was better. The Greek genius was philosophical, lucid and logical. The men of this group were primarily asking philosophical questions. What is the substratum of nature? Is it fire, or earth, or water, or some combination of any two, or of all three? Or is it a mere flux, not reducible to some static material? Mathematics interested them mightily. They invented its generality, analysed its premises, and made notable discoveries of theorems by a rigid adherence to deductive reasoning. Their minds were infected with an eager generality. They demanded clear, bold ideas, and strict reasoning from them. All this was excellent; it was genius; it was ideal preparatory work. But it was not science as we understand it. The patience of minute observation was not nearly so prominent. Their genius was not so apt for the state of imaginative muddled suspense which precedes successful inductive generalisation. They were lucid thinkers and bold reasoners.

Of course there were exceptions, and at the very top: for example, Aristotle and Archimedes. Also for patient observation, there were the astronomers. There was a mathematical lucidity about the stars, and a fascination about the small numerable band of run-a-way planets.

Every philosophy is tinged with the colouring of some secret imaginative background, which never emerges explicitly into its trains of reasoning. The Greek view of nature, at least that cosmology transmitted from them to later ages, was essentially dramatic. It is not necessarily wrong for this reason: but it was overwhelmingly dramatic. It thus conceived nature as articulated in the way of a work of dramatic art, for the exemplification of general ideas converging to an end. Nature was differentiated so as to provide its proper end for each thing. There was the centre of the universe as the end of motion for those things which are heavy, and the celestial spheres as the end of motion for those things whose natures lead them upwards. The celestial spheres were for things which are impassible and ingenerable, the lower regions for things passible and generable. Nature was a drama in which each thing played its part.

I do not say that this is a view to which Aristotle would have subscribed without severe reservations, in fact without the sort of reservations which we ourselves would make. But it was the view which subsequent Greek thought extracted from Aristotle and passed on to the Middle Ages. The effect of such an imaginative setting for

nature was to damp down the historical spirit. For it was the end which seemed illuminating, so why bother about the beginning? The Reformation and the scientific movement were two aspects of the historical revolt which was the dominant intellectual movement of the later Renaissance. The appeal to the origins of Christianity, and Francis Bacon's appeal to efficient causes as against final causes, were two sides of one movement of thought. Also for this reason Galileo and his adversaries were at hopeless cross purposes, as can be seen from his *Dialogues on the Two Systems of the World.*

Galileo keeps harping on how things happen, whereas his adversaries had a complete theory as to why things happen. Unfortunately the two theories did not bring out the same results. Galileo insists upon 'irreducible and stubborn facts,' and Simplicius, his opponent, brings forward reasons, completely satisfactory, at least to himself. It is a great mistake to conceive this historical revolt as an appeal to reason. On the contrary, it was through and through an anti-intellectualist movement. It was the return to the contemplation of brute fact; and it was based on a recoil from the inflexible rationality of medieval thought. In making this statement I am merely summarising what at the time the adherents of the old régime themselves asserted. For example, in the fourth book of Father Paul Sarpi's *History of the Council of Trent,* you will find that in the year 1551 the Papal Legates who presided over the Council ordered: 'That the Divines ought to confirm their opinions with the holy Scripture, Traditions of the Apostles, sacred and approved Councils, and by the Constitutions and Authorities of the holy Fathers; that they ought to use brevity, and avoid superfluous and unprofitable questions, and perverse contentions. . . . This order did not please the Italian Divines; who said it was a novity, and a condemning of School-Divinity, which, in all difficulties, *useth reason,* and because it was not lawful [*i.e.,* by this decree] to treat as St. Thomas [Aquinas], St. Bonaventure, and other famous men did.'

It is impossible not to feel sympathy with these Italian divines, maintaining the lost cause of unbridled rationalism. They were deserted on all hands. The Protestants were in full revolt against them. The Papacy failed to support them, and the Bishops of the Council could not even understand them. For a few sentences below the foregoing quotation, we read: 'Though many complained here-of [*i.e.,* of the Decree], yet it prevailed but little, because generally the

Fathers [*i.e.*, the Bishops] desired to hear men speak with intelligible terms, not abstrusely, as in the matter of Justification, and others already handled.'

Poor belated medievalists! When they used reason they were not even intelligible to the ruling powers of their epoch. It will take centuries before stubborn facts are reducible by reason, and meanwhile the pendulum swings slowly and heavily to the extreme of the historical method.

Forty-three years after the Italian divines had written this memorial, Richard Hooker in his famous *Laws of Ecclesiastical Polity* makes exactly the same complaint of his Puritan adversaries.* Hooker's balanced thought—from which the appellation 'The Judicious Hooker' is derived—and his diffuse style, which is the vehicle of such thought, make his writings singularly unfit for the process of summarising by a short, pointed quotation. But, in the section referred to, he reproaches his opponents with *Their Disparagement of Reason;* and in support of his own position definitely refers to 'The greatest amongst the school-divines' by which designation I presume that he refers to St. Thomas Aquinas.

Hooker's *Ecclesiastical Polity* was published just before Sarpi's *Council of Trent*. Accordingly there was complete independence between the two works. But both the Italian divines of 1551, and Hooker at the end of that century testify to the anti-rationalist trend of thought at that epoch, and in this respect contrast their own age with the epoch of scholasticism.

This reaction was undoubtedly a very necessary corrective to the unguarded rationalism of the Middle Ages. But reactions run to extremes. Accordingly, although one outcome of this reaction was the birth of modern science, yet we must remember that science thereby inherited the bias of thought to which it owes its origin.

The effect of Greek dramatic literature was many-sided so far as concerns the various ways in which it indirectly affected medieval thought. The pilgrim fathers of the scientific imagination as it exists today are the great tragedians of ancient Athens, Aeschylus, Sophocles, Euripides. Their vision of fate, remorseless and indifferent, urging a tragic incident to its inevitable issue, is the vision possessed by science. Fate in Greek Tragedy becomes the order of nature in modern thought. The absorbing interest in the particular heroic incidents,

* Cf. Book III, Sec. viii.

as an example and a verification of the workings of fate, reappears in our epoch as concentration of interest on the crucial experiments. It was my good fortune to be present at the meeting of the Royal Society in London when the Astronomer Royal for England announced that the photographic plates of the famous eclipse, as measured by his colleagues in Greenwich Observatory, had verified the prediction of Einstein that rays of light are bent as they pass in the neighbourhood of the sun. The whole atmosphere of tense interest was exactly that of the Greek drama: we were the chorus commenting on the decree of destiny as disclosed in the development of a supreme incident. There was dramatic quality in the very staging:—the traditional ceremonial, and in the background the picture of Newton to remind us that the greatest of scientific generalisations was now, after more than two centuries, to receive its first modification. Nor was the personal interest wanting: a great adventure in thought had at length come safe to shore.

Let me here remind you that the essence of dramatic tragedy is not unhappiness. It resides in the solemnity of the remorseless working of things. This inevitableness of destiny can only be illustrated in terms of human life by incidents which in fact involve unhappiness. For it is only by them that the futility of escape can be made evident in the drama. This remorseless inevitableness is what pervades scientific thought. The laws of physics are the decrees of fate.

The conception of the moral order in the Greek plays was certainly not a discovery of the dramatists. It must have passed into the literary tradition from the general serious opinion of the times. But in finding this magnificent expression, it thereby deepened the stream of thought from which it arose. The spectacle of a moral order was impressed upon the imagination of classical civilisation.

The time came when that great society decayed, and Europe passed into the Middle Ages. The direct influence of Greek literature vanished. But the concept of the moral order and of the order of nature had enshrined itself in the Stoic philosophy. For example, Lecky in his *History of European Morals* tells us 'Seneca maintains that the Divinity has determined all things by an inexorable law of destiny, which He has decreed, but which He Himself obeys.' But the most effective way in which the Stoics influenced the mentality of the Middle Ages was by the diffused sense of order which arose from Roman law. Again to quote Lecky, 'The Roman legislation was in a

twofold manner the child of philosophy. It was in the first place formed upon the philosophical model, for, instead of being a mere empirical system adjusted to the existing requirements of society, it laid down abstract principles of right to which it endeavoured to conform; and, in the next place, these principles were borrowed directly from Stoicism.' In spite of the actual anarchy throughout large regions in Europe after the collapse of the Empire, the sense of legal order always haunted the racial memories of the Imperial populations. Also the Western Church was always there as a living embodiment of the traditions of Imperial rule.

It is important to notice that this legal impress upon medieval civilisation was not in the form of a few wise precepts which should permeate conduct. It was the conception of a definite articulated system which defines the legality of the detailed structure of social organism, and of the detailed way in which it should function. There was nothing vague. It was not a question of admirable maxims, but of definite procedure to put things right and to keep them there. The Middle Ages formed one long training of the intellect of Western Europe in the sense of order. There may have been some deficiency in respect to practice. But the idea never for a moment lost its grip. It was preëminently an epoch of orderly thought, rationalist through and through. The very anarchy quickened the sense for coherent system; just as the modern anarchy of Europe has stimulated the intellectual vision of a League of Nations.

But for science something more is wanted than a general sense of the order in things. It needs but a sentence to point out how the habit of definite exact thought was implanted in the European mind by the long dominance of scholastic logic and scholastic divinity. The habit remained after the philosophy had been repudiated, the priceless habit of looking for an exact point and of sticking to it when found. Galileo owes more to Aristotle than appears on the surface of his *Dialogues:* he owes to him his clear head and his analytic mind.

I do not think, however, that I have even yet brought out the greatest contribution of medievalism to the formation of the scientific movement. I mean the inexpugnable belief that every detailed occurrence can be correlated with its antecedents in a perfectly definite manner, exemplifying general principles. Without this belief the incredible labours of scientists would be without hope. It is this instinctive conviction, vividly poised before the imagination, which is the motive

power of research:—that there is a secret, a secret which can be unveiled. How has this conviction been so vividly implanted on the European mind?

When we compare this tone of thought in Europe with the attitude of other civilisations when left to themselves, there seems but one source for its origin. It must come from the medieval insistence on the rationality of God, conceived as with the personal energy of Jehovah and with the rationality of a Greek philosopher. Every detail was supervised and ordered: the search into nature could only result in the vindication of the faith in rationality. Remember that I am not talking of the explicit beliefs of a few individuals. What I mean is the impress on the European mind arising from the unquestioned faith of centuries. By this I mean the instinctive tone of thought and not a mere creed of words.

In Asia, the conceptions of God were of a being who was either too arbitrary or too impersonal for such ideas to have much effect on instinctive habits of mind. Any definite occurrence might be due to the fiat of an irrational despot, or might issue from some impersonal, inscrutable origin of things. There was not the same confidence as in the intelligible rationality of a personal being. I am not arguing that the European trust in the scrutability of nature was logically justified even by its own theology. My only point is to understand how it arose. My explanation is that the faith in the possibility of science, generated antecedently to the development of modern scientific theory, is an unconscious derivative from medieval theology.

But science is not merely the outcome of instinctive faith. It also requires an active interest in the simple occurrences of life for their own sake.

This qualification 'for their own sake' is important. The first phase of the Middle Ages was an age of symbolism. It was an age of vast ideas, and of primitive technique. There was little to be done with nature, except to coin a hard living from it. But there were realms of thought to be explored, realms of philosophy and realms of theology. Primitive art could symbolise those ideas which filled all thoughtful minds. The first phase of medieval art has a haunting charm beyond compare: its own intrinsic quality is enhanced by the fact that its message, which stretched beyond art's own self-justification of aesthetic achievement, was the symbolism of things lying behind na-

ture itself. In this symbolic phase, medieval art energised in nature as its medium, but pointed to another world.

In order to understand the contrast between these early Middle Ages and the atmosphere required by the scientific mentality, we should compare the sixth century in Italy with the sixteenth century. In both centuries the Italian genius was laying the foundations of a new epoch. The history of the three centuries preceding the earlier period, despite the promise for the future introduced by the rise of Christianity, is overwhelmingly infected by the sense of the decline of civilisation. In each generation something has been lost. As we read the records, we are haunted by the shadow of the coming barbarism. There are great men, with fine achievements in action or in thought. But their total effect is merely for some short time to arrest the general decline. In the sixth century we are, so far as Italy is concerned, at the lowest point of the curve. But in that century every action is laying the foundation for the tremendous rise of the new European civilisation. In the background the Byzantine Empire, under Justinian, in three ways determined the character of the early Middle Ages in Western Europe. In the first place, its armies, under Belisarius and Narses, cleared Italy from the Gothic domination. In this way, the stage was freed for the exercise of the old Italian genius for creating organisations which shall be protective of ideals of cultural activity. It is impossible not to sympathise with the Goths: yet there can be no doubt but that a thousand years of the Papacy were infinitely more valuable for Europe than any effects derivable from a well-established Gothic kingdom of Italy.

In the second place, the codification of the Roman law established the ideal of legality which dominated the sociological thought of Europe in the succeeding centuries. Law is both an engine for government, and a condition restraining government. The canon law of the Church, and the civil law of the State, owe to Justinian's lawyers their influence on the development of Europe. They established in the Western mind the ideal that an authority should be at once lawful, and law-enforcing, and should in itself exhibit a rationally adjusted system of organisation. The sixth century in Italy gave the initial exhibition of the way in which the impress of these ideas was fostered by contact with the Byzantine Empire.

Thirdly, in the non-political spheres of art and learning Constan-

tinople exhibited a standard of realised achievement which, partly by the impulse to direct imitation, and partly by the indirect inspiration arising from the mere knowledge that such things existed, acted as a perpetual spur to Western culture. The wisdom of the Byzantines, as it stood in the imagination of the first phase of medieval mentality, and the wisdom of the Egyptians as it stood in the imagination of the early Greeks, played analogous rôles. Probably the actual knowledge of these respective wisdoms was, in either case, about as much as was good for the recipients. They knew enough to know the sort of standards which are attainable, and not enough to be fettered by static and traditional ways of thought. Accordingly, in both cases men went ahead on their own and did better. No account of the rise of the European scientific mentality can omit some notice of this influence of the Byzantine civilisation in the background. In the sixth century there is a crisis in the history of the relations between the Byzantines and the West; and this crisis is to be contrasted with the influence of Greek literature on European thought in the fifteenth and sixteenth centuries. The two outstanding men, who in the Italy of the sixth century laid the foundations of the future, were St. Benedict and Gregory the Great. By reference to them, we can at once see how absolutely in ruins was the approach to the scientific mentality which had been attained by the Greeks. We are at the zero point of scientific temperature. But the life-work of Gregory and of Benedict contributed elements to the reconstruction of Europe which secured that this reconstruction, when it arrived, should include a more effective scientific mentality than that of the ancient world. The Greeks were over-theoretical. For them science was an offshoot of philosophy. Gregory and Benedict were practical men, with an eye for the importance of ordinary things; and they combined this practical temperament with their religious and cultural activities. In particular, we owe it to St. Benedict that the monasteries were the homes of practical agriculturalists, as well as of saints and of artists and men of learning. The alliance of science with technology, by which learning is kept in contact with irreducible and stubborn facts, owes much to the practical bent of the early Benedictines. Modern science derives from Rome as well as from Greece, and this Roman strain explains its gain in an energy of thought kept closely in contact with the world of facts.

But the influence of this contact between the monasteries and the

facts of nature showed itself first in art. The rise of Naturalism in the later Middle Ages was the entry into the European mind of the final ingredient necessary for the rise of science. It was the rise of interest in natural objects and in natural occurrences, for their own sakes. The natural foliage of a district was sculptured in out-of-the-way spots of the later buildings, merely as exhibiting delight in those familiar objects. The whole atmosphere of every art exhibited a direct joy in the apprehension of the things which lie around us. The craftsmen who executed the late medieval decorative sculpture, Giotto, Chaucer, Wordsworth, Walt Whitman, and, at the present day, the New England poet Robert Frost, are all akin to each other in this respect. The simple immediate facts are the topics of interest, and these reappear in the thought of science as the 'irreducible stubborn facts.'

The mind of Europe was now prepared for its new venture of thought. It is unnecessary to tell in detail the various incidents which marked the rise of science: the growth of wealth and leisure; the expansion of universities; the invention of printing; the taking of Constantinople; Copernicus; Vasco da Gama; Columbus; the telescope. The soil, the climate, the seeds, were there, and the forest grew. Science has never shaken off the impress of its origin in the historical revolt of the later Renaissance. It has remained predominantly an anti-rationalistic movement, based upon a naïve faith. What reasoning it has wanted, has been borrowed from mathematics which is a surviving relic of Greek rationalism, following the deductive method. Science repudiates philosophy. In other words, it has never cared to justify its faith or to explain its meanings; and has remained blandly indifferent to its refutation by Hume.

Of course the historical revolt was fully justified. It was wanted. It was more than wanted: it was an absolute necessity for healthy progress. The world required centuries of contemplation of irreducible and stubborn facts. It is difficult for men to do more than one thing at a time, and that was the sort of thing they had to do after the rationalistic orgy of the Middle Ages. It was a very sensible reaction; but it was not a protest on behalf of reason.

There is, however, a Nemesis which waits upon those who deliberately avoid avenues of knowledge. Oliver Cromwell's cry echoes down the ages, 'My brethren, by the bowels of Christ I beseech you, bethink you that you may be mistaken.'

The progress of science has now reached a turning point. The stable foundations of physics have broken up: also for the first time physiology is asserting itself as an effective body of knowledge, as distinct from a scrap-heap. The old foundations of scientific thought are becoming unintelligible. Time, space, matter, material, ether, electricity, mechanism, organism, configuration, structure, pattern, function, all require reinterpretation. What is the sense of talking about a mechanical explanation when you do not know what you mean by mechanics?

The truth is that science started its modern career by taking over ideas derived from the weakest side of the philosophies of Aristotle's successors. In some respects it was a happy choice. It enabled the knowledge of the seventeenth century to be formularised so far as physics and chemistry were concerned, with a completeness which has lasted to the present time. But the progress of biology and psychology has probably been checked by the uncritical assumption of half-truths. If science is not to degenerate into a medley of *ad hoc* hypotheses, it must become philosophical and must enter upon a thorough criticism of its own foundations.

In the succeeding lectures of this course, I shall trace the successes and the failures of the particular conceptions of cosmology with which the European intellect has clothed itself in the last three centuries. General climates of opinion persist for periods of about two to three generations, that is to say, for periods of sixty to a hundred years. There are also shorter waves of thought, which play on the surface of the tidal movement. We shall find, therefore, transformations in the European outlook, slowly modifying the successive centuries. There persists, however, throughout the whole period the fixed scientific cosmology which presupposes the ultimate fact of an irreducible brute matter, or material, spread throughout space in a flux of configurations. In itself such a material is senseless, valueless, purposeless. It just does what it does do, following a fixed routine imposed by external relations which do not spring from the nature of its being. It is this assumption that I call 'scientific materialism.' Also it is an assumption which I shall challenge as being entirely unsuited to the scientific situation at which we have now arrived. It is not wrong, if properly construed. If we confine ourselves to certain types of facts, abstracted from the complete circumstances in which they occur, the materialistic assumption expresses these facts to perfection.

But when we pass beyond the abstraction, either by more subtle employment of our senses, or by the request for meanings and for coherence of thoughts, the scheme breaks down at once. The narrow efficiency of the scheme was the very cause of its supreme methodological success. For it directed attention to just those groups of facts which, in the state of knowledge then existing, required investigation.

The success of the scheme has adversely affected the various currents of European thought. The historical revolt was anti-rationalistic, because the rationalism of the scholastics required a sharp correction by contact with brute fact. But the revival of philosophy in the hands of Descartes and his successors was entirely coloured in its development by the acceptance of the scientific cosmology at its face value. The success of their ultimate ideas confirmed scientists in their refusal to modify them as the result of an enquiry into their rationality. Every philosophy was bound in some way or other to swallow them whole. Also the example of science affected other regions of thought. The historical revolt has thus been exaggerated into the exclusion of philosophy from its proper rôle of harmonising the various abstractions of methodological thought. Thought is abstract; and the intolerant use of abstractions is the major vice of the intellect. This vice is not wholly corrected by the recurrence to concrete experience. For after all, you need only attend to those aspects of your concrete experience which lie within some limited scheme. There are two methods for the purification of ideas. One of them is dispassionate observation by means of the bodily senses. But observation is selection. Accordingly, it is difficult to transcend a scheme of abstraction whose success is sufficiently wide. The other method is by comparing the various schemes of abstraction which are well founded in our various types of experience. This comparison takes the form of satisfying the demands of the Italian scholastic divines whom Paul Sarpi mentioned. They asked that *reason* should be used. Faith in reason is the trust that the ultimate natures of things lie together in a harmony which excludes mere arbitrariness. It is the faith that at the base of things we shall not find mere arbitrary mystery. The faith in the order of nature which has made possible the growth of science is a particular example of a deeper faith. This faith cannot be justified by any inductive generalisation. It springs from direct inspection of the nature of things as disclosed in our own immediate present experience. There is no parting from your own shadow. To experience this faith

is to know that in being ourselves we are more than ourselves: to know that our experience, dim and fragmentary as it is, yet sounds the utmost depths of reality: to know that detached details merely in order to be themselves demand that they should find themselves in a system of things: to know that this system includes the harmony of logical rationality, and the harmony of aesthetic achievement: to know that, while the harmony of logic lies upon the universe as an iron necessity, the aesthetic harmony stands before it as a living ideal moulding the general flux in its broken progress towards finer, subtler issues.

CHAPTER II *MATHEMATICS AS AN ELEMENT IN THE HISTORY OF THOUGHT*

The science of Pure Mathematics, in its modern developments, may claim to be the most original creation of the human spirit. Another claimant for this position is music. But we will put aside all rivals, and consider the ground on which such a claim can be made for mathematics. The originality of mathematics consists in the fact that in mathematical science connections between things are exhibited which, apart from the agency of human reason, are extremely unobvious. Thus the ideas, now in the minds of contemporary mathematicians, lie very remote from any notions which can be immediately derived by perception through the senses; unless indeed it be perception stimulated and guided by antecedent mathematical knowledge. This is the thesis which I proceed to exemplify.

Suppose we project our imagination backwards through many thousands of years, and endeavour to realise the simple-mindedness of even the greatest intellects in those early societies. Abstract ideas which to us are immediately obvious must have been, for them, matters only of the most dim apprehension. For example take the question of number. We think of the number 'five' as applying to appropriate groups of any entities whatsoever—to five fishes, five children, five apples, five days. Thus in considering the relations of the number 'five' to the number 'three,' we are thinking of two groups of things, one with five members and the other with three members. But we

are entirely abstracting from any consideration of any particular entities, or even of any particular sorts of entities, which go to make up the membership of either of the two groups. We are merely thinking of those relationships between those two groups which are entirely independent of the individual essences of any of the members of either group. This is a very remarkable feat of abstraction; and it must have taken ages for the human race to rise to it. During a long period, groups of fishes will have been compared to each other in respect to their multiplicity, and groups of days to each other. But the first man who noticed the analogy between a group of seven fishes and a group of seven days made a notable advance in the history of thought. He was the first man who entertained a concept belonging to the science of pure mathematics. At that moment it must have been impossible for him to divine the complexity and subtlety of these abstract mathematical ideas which were waiting for discovery. Nor could he have guessed that these notions would exert a widespread fascination in each succeeding generation. There is an erroneous literary tradition which represents the love of mathematics as a monomania confined to a few eccentrics in each generation. But be this as it may, it would have been impossible to anticipate the pleasure derivable from a type of abstract thinking which had no counterpart in the then-existing society. Thirdly, the tremendous future effect of mathematical knowledge on the lives of men, on their daily avocations, on their habitual thoughts, on the organization of society, must have been even more completely shrouded from the foresight of those early thinkers. Even now there is a very wavering grasp of the true position of mathematics as an element in the history of thought. I will not go so far as to say that to construct a history of thought without profound study of the mathematical ideas of successive epochs is like omitting Hamlet from the play which is named after him. That would be claiming too much. But it is certainly analogous to cutting out the part of Ophelia. This simile is singularly exact. For Ophelia is quite essential to the play, she is very charming—and a little mad. Let us grant that the pursuit of mathematics is a divine madness of the human spirit, a refuge from the goading urgency of contingent happenings.

When we think of mathematics, we have in our mind a science devoted to the exploration of number, quantity, geometry, and in modern times also including investigation into yet more abstract con-

cepts of order, and into analogous types of purely logical relations. The point of mathematics is that in it we have always got rid of the particular instance, and even of any particular sorts of entities. So that for example, no mathematical truths apply merely to fish, or merely to stones, or merely to colours. So long as you are dealing with pure mathematics, you are in the realm of complete and absolute abstraction. All you assert is, that reason insists on the admission that, if any entities whatever have any relations which satisfy such-and-such purely abstract conditions, then they must have other relations which satisfy other purely abstract conditions.

Mathematics is thought moving in the sphere of complete abstraction from any particular instance of what it is talking about. So far is this view of mathematics from being obvious, that we can easily assure ourselves that it is not, even now, generally understood. For example, it is habitually thought that the certainty of mathematics is a reason for the certainty of our geometrical knowledge of the space of the physical universe. This is a delusion which has vitiated much philosophy in the past, and some philosophy in the present. This question of geometry is a test case of some urgency. There are certain alternative sets of purely abstract conditions possible for the relationship of groups of unspecified entities, which I will call *geometrical conditions*. I give them this name because of their general analogy to those conditions, which we believe to hold respecting the particular geometrical relations of things observed by us in our direct perception of nature. So far as our observations are concerned, we are not quite accurate enough to be certain of the exact conditions regulating the things we come across in nature. But we can by a slight stretch of hypothesis identify these observed conditions with some one set of the purely abstract geometrical conditions. In doing so, we make a particular determination of the group of unspecified entities which are the *relata* in the abstract science. In the pure mathematics of geometrical relationships, we say that, if *any* group entities enjoy *any* relationships among its members satisfying *this* set of abstract geometrical conditions, then such-and-such additional abstract conditions must also hold for such relationships. But when we come to physical space, we say that some definitely observed group of physical entities enjoys some definitely observed relationships among its members which do satisfy this above-mentioned set of abstract geometrical conditions. We thence conclude

that the additional relationships which we concluded to hold in *any* such case, must therefore hold in *this particular* case.

The certainty of mathematics depends upon its complete abstract generality. But we can have no *a priori* certainty that we are right in believing that the observed entities in the concrete universe form a particular instance of what falls under our general reasoning. To take another example from arithmetic. It is a general abstract truth of pure mathematics that any group of forty entities can be subdivided into two groups of twenty entities. We are therefore justified in concluding that a particular group of apples which we believe to contain forty members can be subdivided into two groups of apples of which each contains twenty members. But there always remains the possibility that we have miscounted the big group; so that, when we come in practice to subdivide it, we shall find that one of the two heaps has an apple too few or an apple too many.

Accordingly, in criticising an argument based upon the application of mathematics to particular matters of fact there are always three processes to be kept perfectly distinct in our minds. We must first scan the purely mathematical reasoning to make sure that there are no mere slips in it—no casual illogicalities due to mental failure. Any mathematician knows from bitter experience that, in first elaborating a train of reasoning, it is very easy to commit a slight error which yet makes all the difference. But when a piece of mathematics has been revised, and has been before the expert world for some time, the chance of a casual error is almost negligible. The next process is to make quite certain of all the abstract conditions which have been presupposed to hold. This is the determination of the abstract premises from which the mathematical reasoning proceeds. This is a matter of considerable difficulty. In the past quite remarkable oversights have been made, and have been accepted by generations of the greatest mathematicians. The chief danger is that of oversight, namely, tacitly to introduce some condition, which it is natural for us to presuppose, but which in fact need not always be holding. There is another opposite oversight in this connection which does not lead to error, but only to lack of simplification. It is very easy to think that more postulated conditions are required than is in fact the case. In other words, we may think that some abstract postulate is necessary which is in fact capable of being proved from the other postulates that we have already on hand. The only effects of this

excess of abstract postulates are to diminish our aesthetic pleasure in the mathematical reasoning, and to give us more trouble when we come to the third process of criticism.

This third process of criticism is that of verifying that our abstract postulates hold for the particular case in question. It is in respect to this process of verification for the particular case that all the trouble arises. In some simple instances, such as the counting of forty apples, we can with a little care arrive at practical certainty. But in general, with more complex instances, complete certainty is unattainable. Volumes, libraries of volumes, have been written on the subject. It is the battleground of rival philosophers. There are two distinct questions involved. There are particular definite things observed, and we have to make sure that the relations between these things really do obey certain definite exact abstract conditions. There is great room for error here. The exact observational methods of science are all contrivances for limiting these erroneous conclusions as to direct matters of fact. But another question arises. The things directly observed are, almost always, only samples. We want to conclude that the abstract conditions, which hold for the samples, also hold for all other entities which, for some reason or other, appear to us to be of the same sort. This process of reasoning from the sample to the whole species is Induction. The theory of Induction is the despair of philosophy—and yet all our activities are based upon it. Anyhow, in criticising a mathematical conclusion as to a particular matter of fact, the real difficulties consist in finding out the abstract assumptions involved, and in estimating the evidence for their applicability to the particular case in hand.

It often happens, therefore, that in criticising a learned book of applied mathematics, or a memoir, one's whole trouble is with the first chapter, or even with the first page. For it is there, at the very outset, where the author will probably be found to slip in his assumptions. Farther, the trouble is not with what the author does say, but with what he does not say. Also it is not with what he knows he has assumed, but with what he has unconsciously assumed. We do not doubt the author's honesty. It is his perspicacity which we are criticising. Each generation criticises the unconscious assumptions made by its parents. It may assent to them, but it brings them out in the open.

The history of the development of language illustrates this point.

It is a history of the progressive analysis of ideas. Latin and Greek were inflected languages. This means that they express an unanalysed complex of ideas by the mere modification of a word; whereas in English, for example, we use prepositions and auxiliary verbs to drag into the open the whole bundle of ideas involved. For certain forms of literary art—though not always—the compact absorption of auxiliary ideas into the main word may be an advantage. But in a language such as English there is the overwhelming gain in explicitness. This increased explicitness is a more complete exhibition of the various abstractions involved in the complex idea which is the meaning of the sentence.

By comparison with language, we can now see what is the function in thought which is performed by pure mathematics. It is a resolute attempt to go the whole way in the direction of complete analysis, so as to separate the elements of mere matter of fact from the purely abstract conditions which they exemplify.

The habit of such analysis enlightens every act of the functioning of the human mind. It first (by isolating it) emphasizes the direct aesthetic appreciation of the content of experience. This direct appreciation means an apprehension of what this experience is in itself in its own particular essence, including its immediate concrete values. This is a question of direct experience, dependent upon sensitive subtlety. There is then the abstraction of the particular entities involved, viewed in themselves, and as apart from that particular occasion of experience in which we are then apprehending them. Lastly there is the further apprehension of the absolutely general conditions satisfied by the particular relations of those entities as in that experience. These conditions gain their generality from the fact that they are expressible without reference to those particular relations or to those particular relata which occur in that particular occasion of experience. They are conditions which might hold for an indefinite variety of other occasions, involving other entities and other relations between them. Thus these conditions are perfectly general because they refer to no particular occasion, and to no particular entities (such as green, or blue, or trees) which enter into a variety of occasions, and to no particular relationships between such entities.

There is, however, a limitation to be made to the generality of mathematics; it is a qualification which applies equally to all general statements. No statement, except one, can be made respecting any

remote occasion which enters into no relationship with the immediate occasion so as to form a constitutive element of the essence of that immediate occasion. By the 'immediate occasion' I mean that occasion which involves as an ingredient the individual act of judgment in question. The one excepted statement is:—If anything out of relationship, then complete ignorance as to it. Here by 'ignorance,' I mean *ignorance;* accordingly no advice can be given as to how to expect it, or to treat it, in 'practice' or in any other way. Either we know something of the remote occasion by the cognition which is itself an element of the immediate occasion, or we know nothing. Accordingly the full universe, disclosed for every variety of experience, is a universe in which every detail enters into its proper relationship with the immediate occasion. The generality of mathematics is the most complete generality consistent with the community of occasions which constitutes our metaphysical situation.

It is further to be noticed that the particular entities require these general conditions for their ingression into any occasions; but the same general conditions may be required by many types of particular entities. This fact, that the general conditions transcend any one set of particular entities, is the ground for the entry into mathematics, and into mathematical logic, of the notion of the 'variable.' It is by the employment of this notion that general conditions are investigated without any specification of particular entities. This irrelevance of the particular entities has not been generally understood: for example, the shape-iness of shapes, *e.g.,* circularity and sphericity and cubicality as in actual experience, do not enter into the geometrical reasoning.

The exercise of logical reason is always concerned with these absolutely general conditions. In its broadest sense, the discovery of mathematics is the discovery that the totality of these general abstract conditions, which are concurrently applicable to the relationships among the entities of any one concrete occasion, are themselves interconnected in the manner of a pattern with a key to it. This pattern of relationships among general abstract conditions is imposed alike on external reality, and on our abstract representations of it, by the general necessity that everything must be just its own individual self, with its own individual way of differing from everything else. This is nothing else than the necessity of abstract logic, which is the presup-

position involved in the very fact of inter-related existence as disclosed in each immediate occasion of experience.

The key to the patterns means this fact:—that from a select set of those general conditions, exemplified in any one and the same occasion, a pattern involving an infinite variety of other such conditions, also exemplified in the same occasion, can be developed by the pure exercise of abstract logic. Any such select set is called the set of postulates, or premises, from which the reasoning proceeds. The reasoning is nothing else than the exhibition of the whole pattern of general conditions involved in the pattern derived from the selected postulates.

The harmony of the logical reason, which divines the complete pattern as involved in the postulates, is the most general aesthetic property arising from the mere fact of concurrent existence in the unity of one occasion. Wherever there is a unity of occasion there is thereby established an aesthetic relationship between the general conditions involved in that occasion. This aesthetic relationship is that which is divined in the exercise of rationality. Whatever falls within that relationship is thereby exemplified in that occasion, whatever falls without that relationship is thereby excluded from exemplification in that occasion. The complete pattern of general conditions, thus exemplified, is determined by any one of many select sets of these conditions. These key sets are sets of equivalent postulates. This reasonable harmony of being, which is required for the unity of a complex occasion, together with the completeness of the realisation (in that occasion) of all that is involved in its logical harmony, is the primary article of metaphysical doctrine. It means that for things to be together involves that they are reasonably together. This means that thought can penetrate into every occasion of fact, so that by comprehending its key conditions, the whole complex of its pattern of conditions lies open before it. It comes to this:—provided we know something which is perfectly general about the elements in any occasion, we can then know an indefinite number of other equally general concepts which must also be exemplified in that same occasion. The logical harmony involved in the unity of an occasion is both exclusive and inclusive. The occasion must exclude the inharmonious, and it must include the harmonious.

Pythagoras was the first man who had any grasp of the full sweep

of this general principle. He lived in the sixth century before Christ. Our knowledge of him is fragmentary. But we know some points which establish his greatness in the history of thought. He insisted on the importance of the utmost generality in reasoning, and he divined the importance of number as an aid to the construction of any representation of the conditions involved in the order of nature. We know also that he studied geometry, and discovered the general proof of the remarkable theorem about right-angled triangles. The formation of the Pythagorean Brotherhood, and the mysterious rumours as to its rites and its influence, afford some evidence that Pythagoras divined, however dimly, the possible importance of mathematics in the formation of science. On the side of philosophy he started a discussion which has agitated thinkers ever since. He asked, 'What is the status of mathematical entities, such as numbers for example, in the realm of things?' The number 'two,' for example, is in some sense exempt from the flux of time and the necessity of position in space. Yet it is involved in the real world. The same considerations apply to geometrical notions—to circular shape, for example. Pythagoras is said to have taught that the mathematical entities, such as numbers and shapes, were the ultimate stuff out of which the real entities of our perceptual experience are constructed. As thus baldly stated, the idea seems crude, and indeed silly. But undoubtedly, he had hit upon a philosophical notion of considerable importance; a notion which has a long history, and which has moved the minds of men, and has even entered into Christian theology. About a thousand years separate the Athanasian Creed from Pythagoras, and about two thousand four hundred years separate Pythagoras from Hegel. Yet for all these distances in time, the importance of definite number in the constitution of the Divine Nature, and the concept of the real world as exhibiting the evolution of an idea, can both be traced back to the train of thought set going by Pythagoras.

The importance of an individual thinker owes something to chance. For it depends upon the fate of his ideas in the minds of his successors. In this respect Pythagoras was fortunate. His philosophical speculations reach us through the mind of Plato. The Platonic world of ideas is the refined, revised form of the Pythagorean doctrine that number lies at the base of the real world. Owing to the Greek mode of representing numbers by patterns of dots, the notions of number and of geometrical configuration are less separated than with us.

Also Pythagoras, without doubt, included the shape-iness of shape, which is an impure mathematical entity. So to-day, when Einstein and his followers proclaim that physical facts, such as gravitation, are to be construed as exhibitions of local peculiarities of spatio-temporal properties, they are following the pure Pythagorean tradition. In a sense, Plato and Pythagoras stand nearer to modern physical science than does Aristotle. The two former were mathematicians, whereas Aristotle was the son of a doctor, though of course he was not thereby ignorant of mathematics. The practical counsel to be derived from Pythagoras, is to measure, and thus to express quality in terms of numerically determined quantity. But the biological sciences, then and till our own time, have been overwhelmingly classificatory. Accordingly, Aristotle by his Logic throws the emphasis on classification. The popularity of Aristotelian Logic retarded the advance of physical science throughout the Middle Ages. If only the schoolmen had measured instead of classifying, how much they might have learnt!

Classification is a halfway house between the immediate concreteness of the individual thing and the complete abstraction of mathematical notions. The species take account of the specific character, and the genera of the generic character. But in the procedure of relating mathematical notions to the facts of nature, by counting, by measurement, and by geometrical relations, and by types of order, the rational contemplation is lifted from the incomplete abstractions involved in definite species and genera, to the complete abstractions of mathematics. Classification is necessary. But unless you can progress from classification to mathematics, your reasoning will not take you very far.

Between the epoch which stretches from Pythagoras to Plato and the epoch comprised in the seventeenth century of the modern world nearly two thousand years elapsed. In this long interval mathematics had made immense strides. Geometry had gained the study of conic sections and trigonometry; the method of exhaustion had almost anticipated the integral calculus; and above all the Arabic arithmetical notation and algebra had been contributed by Asiatic thought. But the progress was on technical lines. Mathematics, as a formative element in the development of philosophy, never, during this long period, recovered from its deposition at the hands of Aristotle. Some of the old ideas derived from the Pythagorean-Platonic epoch

lingered on, and can be traced among the Platonic influences which shaped the first period of evolution of Christian theology. But philosophy received no fresh inspiration from the steady advance of mathematical science. In the seventeenth century the influence of Aristotle was at its lowest, and mathematics recovered the importance of its earlier period. It was an age of great physicists and great philosophers; and the physicists and philosophers were alike mathematicians. The exception of John Locke should be made; although he was greatly influenced by the Newtonian circle of the Royal Society. In the age of Galileo, Descartes, Spinoza, Newton, and Leibniz, mathematics was an influence of the first magnitude in the formation of philosophic ideas. But the mathematics, which now emerged into prominence, was a very different science from the mathematics of the earlier epoch. It had gained in generality, and had started upon its almost incredible modern career of piling subtlety of generalisation upon subtlety of generalisation; and of finding, with each growth of complexity, some new application, either to physical science, or to philosophic thought. The Arabic notation had equipped the science with almost perfect technical efficiency in the manipulation of numbers. This relief from a struggle with arithmetical details (as instanced, for example, in the Egyptian arithmetic of 1600 B.C.) gave room for a development which had already been faintly anticipated in later Greek mathematics. Algebra now came upon the scene, and algebra is a generalisation of arithmetic. In the same way as the notion of number abstracted from reference to any one particular set of entities, so in algebra abstraction is made from the notion of any particular numbers. Just as the number '5' refers impartially to any group of five entities, so in algebra the letters are used to refer impartially to any number, with the proviso that each letter is to refer to the same number throughout the same context of its employment.

This usage was first employed in equations, which are methods of asking complicated arithmetical questions. In this connexion, the letters representing numbers were termed 'unknowns.' But equations soon suggested a new idea, that, namely, of a function of one or more general symbols, these symbols being letters representing any numbers. In this employment the algebraic letters are called the 'arguments' of the function, or sometimes they are called the 'variables.' Then, for instance, if an angle is represented by an algebraical letter, as standing for its numerical measure in terms of a given unit,

trigonometry is absorbed into this new algebra. Algebra thus develops into the general science of analysis in which we consider the properties of various functions of undetermined arguments. Finally the particular functions, such as the trigonometrical functions, and the logarithmic functions, and the algebraic functions, are generalised into the idea of 'any function.' Too large a generalisation leads to mere barrenness. It is the large generalisation, limited by a happy particularity, which is the fruitful conception. For instance the idea of any *continuous* function, whereby the limitation of continuity is introduced, is the fruitful idea which has led to most of the important applications. This rise of algebraic analysis was concurrent with Descartes' discovery of analytical geometry, and then with the invention of the infinitesimal calculus by Newton and Leibniz. Truly, Pythagoras, if he could have foreseen the issue of the train of thought which he had set going would have felt himself fully justified in his brotherhood with its excitement of mysterious rites.

The point which I now want to make is that this dominance of the idea of functionality in the abstract sphere of mathematics found itself reflected in the order of nature under the guise of mathematically expressed laws of nature. Apart from this progress of mathematics, the seventeenth century developments of science would have been impossible. Mathematics supplied the background of imaginative thought with which the men of science approached the observation of nature. Galileo produced formulae, Descartes produced formulae, Huyghens produced formulae, Newton produced formulae.

As a particular example of the effect of the abstract development of mathematics upon the science of those times, consider the notion of periodicity. The general recurrences of things are very obvious in our ordinary experience. Days recur, lunar phases recur, the seasons of the year recur, rotating bodies recur to their old positions, beats of the heart recur, breathing recurs. On every side, we are met by recurrence. Apart from recurrence, knowledge would be impossible; for nothing could be referred to our past experience. Also, apart from some regularity of recurrence, measurement would be impossible. In our experience, as we gain the idea of exactness, recurrence is fundamental.

In the sixteenth and seventeenth centuries, the theory of periodicity took a fundamental place in science. Kepler divined a law connecting the major axes of the planetary orbits with the periods in which

the planets respectively described their orbits: Galileo observed the periodic vibrations of pendulums: Newton explained sound as being due to the disturbance of air by the passage through it of periodic waves of condensation and rarefaction: Huyghens explained light as being due to the transverse waves of vibration of a subtle ether: Mersenne connected the period of the vibration of a violin string with its density, tension, and length. The birth of modern physics depended upon the application of the abstract idea of periodicity to a variety of concrete instances. But this would have been impossible, unless mathematicians had already worked out in the abstract the various abstract ideas which cluster round the notions of periodicity. The science of trigonometry arose from that of the relations of the angles of a right-angled triangle, to the ratios between the sides and hypotenuse of the triangle. Then, under the influence of the newly discovered mathematical science of the analysis of functions, it broadened out into the study of the simple abstract periodic functions which these ratios exemplify. Thus trigonometry became completely abstract; and in thus becoming abstract, it became useful. It illuminated the underlying analogy between sets of utterly diverse physical phenomena; and at the same time it supplied the weapons by which any one such set could have its various features analysed and related to each other.*

Nothing is more impressive than the fact that as mathematics withdrew increasingly into the upper regions of ever greater extremes of abstract thought, it returned back to earth with a corresponding growth of importance for the analysis of concrete fact. The history of the seventeenth century science reads as though it were some vivid dream of Plato or Pythagoras. In this characteristic the seventeenth century was only the forerunner of its successors.

The paradox is now fully established that the utmost abstractions are the true weapons with which to control our thought of concrete fact. As the result of the prominence of mathematicians in the seventeenth century, the eighteenth century was mathematically minded, more especially where French influence predominated. An exception must be made of the English empiricism derived from Locke. Out-

* For a more detailed consideration of the nature and function of pure mathematics cf. my *Introduction to Mathematics* (Home University Library, Williams and Norgate, London).

side France, Newton's direct influence on philosophy is best seen in Kant, and not in Hume.

In the nineteenth century, the general influence of mathematics waned. The romantic movement in literature, and the idealistic movement in philosophy were not the products of mathematical minds. Also, even in science, the growth of geology, of zoölogy, and of the biological sciences generally, was in each case entirely disconnected from any reference to mathematics. The chief scientific excitement of the century was the Darwinian theory of evolution. Accordingly, mathematicians were in the background so far as the general thought of that age was concerned. But this does not mean that mathematics was being neglected, or even that it was uninfluential. During the nineteenth century pure mathematics made almost as much progress as during all the preceding centuries from Pythagoras onwards. Of course progress was easier, because the technique had been perfected. But allowing for that, the change in mathematics between the years 1800 and 1900 is very remarkable. If we add in the previous hundred years, and take the two centuries preceding the present time, one is almost tempted to date the foundation of mathematics somewhere in the last quarter of the seventeenth century. The period of the discovery of the elements stretches from Pythagoras to Descartes, Newton, and Leibniz, and the developed science has been created during the last two hundred and fifty years. This is not a boast as to the superior genius of the modern world; for it is harder to discover the elements than to develop the science.

Throughout the nineteenth century, the influence of the science was its influence on dynamics and physics, and thence derivatively on engineering and chemistry. It is difficult to overrate its indirect influence on human life through the medium of these sciences. But there was no direct influence of mathematics upon the general thought of the age.

In reviewing this rapid sketch of the influence of mathematics throughout European history, we see that it had two great periods of direct influence upon general thought, both periods lasting for about two hundred years. The first period was that stretching from Pythagoras to Plato, when the possibility of the science, and its general character, first dawned upon the Grecian thinkers. The second period comprised the seventeenth and eighteenth centuries of our modern

epoch. Both periods had certain common characteristics. In the earlier, as in the later period, the general categories of thought in many spheres of human interest, were in a state of disintegration. In the age of Pythagoras, the unconscious Paganism, with its traditional clothing of beautiful ritual and of magical rites, was passing into a new phase under two influences. There were waves of religious enthusiasm, seeking direct enlightenment into the secret depths of being; and at the opposite pole, there was the awakening of critical analytical thought, probing with cool dispassionateness into ultimate meanings. In both influences, so diverse in their outcome, there was one common element—an awakened curiosity, and a movement towards the reconstruction of traditional ways. The pagan mysteries may be compared to the Puritan reaction and to the Catholic reaction; critical scientific interest was alike in both epochs, though with minor differences of substantial importance.

In each age, the earlier stages were placed in periods of rising prosperity, and of new opportunities. In this respect, they differed from the period of gradual declension in the second and third centuries when Christianity was advancing to the conquest of the Roman world. It is only in a period, fortunate both in its opportunities for disengagement from the immediate pressure of circumstances, and in its eager curiosity, that the Age-Spirit can undertake any direct revision of those final abstractions which lie hidden in the more concrete concepts from which the serious thought of an age takes its start. In the rare periods when this task can be undertaken, mathematics becomes relevant to philosophy. For mathematics is the science of the most complete abstractions to which the human mind can attain.

The parallel between the two epochs must not be pressed too far. The modern world is larger and more complex than the ancient civilisation round the shores of the Mediterranean, or even than that of the Europe which sent Columbus and the Pilgrim Fathers across the ocean. We cannot now explain our age by some simple formula which becomes dominant and will then be laid to rest for a thousand years. Thus the temporary submergence of the mathematical mentality from the time of Rousseau onwards appears already to be at an end. We are entering upon an age of reconstruction, in religion, in science, and in political thought. Such ages, if they are to avoid mere ignorant oscillation between extremes, must seek truth in its ultimate depths. There can be no vision of this depth of truth apart

from a philosophy which takes full account of those ultimate abstractions, whose interconnections it is the business of mathematics to explore.

In order to explain exactly how mathematics is gaining in general importance at the present time, let us start from a particular scientific perplexity and consider the notions to which we are naturally led by some attempt to unravel its difficulties. At present physics is troubled by the quantum theory. I need not now explain * what this theory is, to those who are not already familiar with it. But the point is that one of the most hopeful lines of explanation is to assume that an electron does not continuously traverse its path in space. The alternative notion as to its mode of existence is that it appears at a series of discrete positions in space which it occupies for successive durations of time. It is as though an automobile, moving at the average rate of thirty miles an hour along a road, did not traverse the road continuously; but appeared successively at the successive milestones, remaining for two minutes at each milestone.

In the first place there is required the purely technical use of mathematics to determine whether this conception does in fact explain the many perplexing characteristics of the quantum theory. If the notion survives this test, undoubtedly physics will adopt it. So far the question is purely one for mathematics and physical science to settle between them, on the basis of mathematical calculations and physical observations.

But now a problem is handed over to the philosophers. This discontinuous existence in space, thus assigned to electrons, is very unlike the continuous existence of material entities which we habitually assume as obvious. The electron seems to be borrowing the character which some people have assigned to the Mahatmas of Tibet. These electrons, with the correlative protons, are now conceived as being the fundamental entities out of which the material bodies of ordinary experience are composed. Accordingly if this explanation is allowed, we have to revise all our notions of the ultimate character of material existence. For when we penetrate to these final entities, this startling discontinuity of spatial existence discloses itself.

There is no difficulty in explaining the paradox, if we consent to apply to the apparently steady undifferentiated endurance of matter

* Cf. Chapter VIII, *Science and the Modern World.*

the same principles as those now accepted for sound and light. A steadily sounding note is explained as the outcome of vibrations in the air: a steady colour is explained as the outcome of vibrations in ether. If we explain the steady endurance of matter on the same principle, we shall conceive each primordial element as a vibratory ebb and flow of an underlying energy, or activity. Suppose we keep to the physical idea of energy: then each primordial element will be an organised system of vibratory streaming of energy. Accordingly there will be a definite period associated with each element; and within that period the stream-system will sway from one stationary maximum to another stationary maximum—or, taking a metaphor from the ocean tides, the system will sway from one high tide to another high tide. This system, forming the primordial element, is nothing at any instant. It requires its whole period in which to manifest itself. In an analogous way, a note of music is nothing at an instant, but it also requires its whole period in which to manifest itself.

Accordingly, in asking where the primordial element is, we must settle on its average position at the centre of each period. If we divide time into smaller elements, the vibratory system as one electronic entity has no existence. The path in space of such a vibratory entity—where the entity is *constituted by* the vibrations—must be represented by a series of detached positions in space, analogously to the automobile which is found at successive milestones and at nowhere between.

We first must ask whether there is any evidence to associate the quantum theory with vibration. This question is immediately answered in the affirmative. The whole theory centres round the radiant energy from an atom, and is intimately associated with the periods of the radiant wave-systems. It seems, therefore, that the hypothesis of essentially vibratory existence is the most hopeful way of explaining the paradox of the discontinuous orbit.

In the second place, a new problem is now placed before philosophers and physicists, if we entertain the hypothesis that the ultimate elements of matter are in their essence vibratory. By this I mean that apart from being a periodic system, such an element would have no existence. With this hypothesis we have to ask, what are the ingredients which form the vibratory organism. We have already got rid of the matter with its appearance of undifferentiated endurance.

Apart from some metaphysical compulsion, there is no reason to provide another more subtle stuff to take the place of the matter which has just been explained away. The field is now open for the introduction of some new doctrine of organism which may take the place of the materialism with which, since the seventeenth century, science has saddled philosophy. It must be remembered that the physicists' energy is obviously an abstraction. The concrete fact, which is the organism, must be a complete expression of the character of a real occurrence. Such a displacement of scientific materialism, if it ever takes place, cannot fail to have important consequences in every field of thought.

Finally, our last reflection must be, that we have in the end come back to a version of the doctrine of old Pythagoras, from whom mathematics, and mathematical physics, took their rise. He discovered the importance of dealing with abstractions; and in particular directed attention to number as characterising the periodicities of notes of music. The importance of the abstract idea of periodicity was thus present at the very beginning both of mathematics and of European philosophy.

In the seventeenth century, the birth of modern science required a new mathematics, more fully equipped for the purpose of analysing the characteristics of vibratory existence. And now in the twentieth century we find physicists largely engaged in analysing the periodicities of atoms. Truly, Pythagoras in founding European philosophy and European mathematics, endowed them with the luckiest of lucky guesses—or, was it a flash of divine genius, penetrating to the inmost nature of things?

CHAPTER III *THE CENTURY OF GENIUS*

The previous chapters were devoted to the antecedent conditions which prepared the soil for the scientific outburst of the seventeenth century. They traced the various elements of thought and instinctive belief, from their first efflorescence in the classical civilisation of the ancient world, through the transformations which they underwent in the Middle Ages, up to the historical revolt of the sixteenth

century. Three main factors arrested attention—the rise of mathematics, the instinctive belief in a detailed order of nature, and the unbridled rationalism of the thought of the later Middle Ages. By this rationalism I mean the belief that the avenue to truth was predominantly through a metaphysical analysis of the nature of things, which would thereby determine how things acted and functioned. The historical revolt was the definite abandonment of this method in favour of the study of the empirical facts of antecedents and consequences. In religion, it meant the appeal to the origins of Christianity; and in science it meant the appeal to experiment and the inductive method of reasoning.

A brief, and sufficiently accurate, description of the intellectual life of the European races during the succeeding two centuries and a quarter up to our own times is that they have been living upon the accumulated capital of ideas provided for them by the genius of the seventeenth century. The men of this epoch inherited a ferment of ideas attendant upon the historical revolt of the sixteenth century, and they bequeathed formed systems of thought touching every aspect of human life. It is the one century which consistently, and throughout the whole range of human activities, provided intellectual genius adequate for the greatness of its occasions. The crowded stage of this hundred years is indicated by the coincidences which mark its literary annals. At its dawn Bacon's *Advancement of Learning* and Cervantes' *Don Quixote* were published in the same year (1605), as though the epoch would introduce itself with a forward and a backward glance. The first quarto edition of *Hamlet* appeared in the preceding year, and a slightly variant edition in the same year. Finally Shakespeare and Cervantes died on the same day, April 23, 1616. In the spring of this same year Harvey is believed to have first expounded his theory of the circulation of the blood in a course of lectures before the College of Physicians in London. Newton was born in the year that Galileo died (1642), exactly one hundred years after the publication of Copernicus' *De Revolutionibus*. One year earlier Descartes published his *Meditationes* and two years later his *Principia Philosophiae*. There simply was not time for the century to space out nicely its notable events concerning men of genius.

I cannot now enter upon a chronicle of the various stages of intellectual advance included within this epoch. It is too large a topic

for one lecture, and would obscure the ideas which it is my purpose to develop. A mere rough catalogue of some names will be sufficient, names of men who published to the world important work within these limits of time: Francis Bacon, Harvey, Kepler, Galileo, Descartes, Pascal, Huyghens, Boyle, Newton, Locke, Spinoza, Leibniz. I have limited the list to the sacred number of twelve, a number much too small to be properly representative. For example, there is only one Italian there, whereas Italy could have filled the list from its own ranks. Again Harvey is the only biologist, and also there are too many Englishmen. This latter defect is partly due to the fact that the lecturer is English, and that he is lecturing to an audience which, equally with him, owns this English century. If he had been Dutch, there would have been too many Dutchmen; if Italian, too many Italians; and if French, too many Frenchmen. The unhappy Thirty Years' War was devastating Germany; but every other country looks back to this century as an epoch which witnessed some culmination of its genius. Certainly this was a great period of English thought; as at a later time Voltaire impressed upon France.

The omission of physiologists, other than Harvey, also requires explanation. There were, of course, great advances in biology within the century, chiefly associated with Italy and the University of Padua. But my purpose is to trace the philosophic outlook, derived from science and presupposed by science, and to estimate some of its effects on the general climate of each age. Now the scientific philosophy of this age was dominated by physics; so as to be the most obvious rendering, in terms of general ideas, of the state of physical knowledge of that age and of the two succeeding centuries. As a matter of fact, these concepts are very unsuited to biology; and set for it an insoluble problem of matter and life and organism, with which biologists are now wrestling. But the science of living organisms is only now coming to a growth adequate to impress its conceptions upon philosophy. The last half century before the present time has witnessed unsuccessful attempts to impress biological notions upon the materialism of the seventeenth century. However this success be estimated, it is certain that the root ideas of the seventeenth century were derived from the school of thought which produced Galileo, Huyghens and Newton, and not from the physiologists of Padua. One unsolved problem of thought, so far as

it derives from this period, is to be formulated thus: Given configurations of matter with locomotion in space as assigned by physical laws, to account for living organisms.

My discussion of the epoch will be best introduced by a quotation from Francis Bacon, which forms the opening of Section (or 'Century') IX of his *Natural History,* I mean his *Silva Silvarum.* We are told in the contemporary memoir by his chaplain, Dr. Rawley, that this work was composed in the last five years of his life, so it must be dated between 1620 and 1626. The quotation runs thus:

'It is certain that all bodies whatsoever, though they have no sense, yet they have perception; for when one body is applied to another, there is a kind of election to embrace that which is agreeable, and to exclude or expel that which is ingrate; and whether the body be alterant or altered, evermore a perception precedeth operation; for else all bodies would be like one to another. And sometimes this perception, in some kind of bodies, is far more subtile than sense; so that sense is but a dull thing in comparison of it: we see a weatherglass will find the least difference of the weather in heat or cold, when we find it not. And this perception is sometimes at a distance, as well as upon the touch; as when the loadstone draweth iron; or flame naphtha of Babylon, a great distance off. It is therefore a subject of a very noble enquiry, to enquire of the more subtile perceptions; for it is another key to open nature, as well as the sense; and sometimes better. And besides, it is a principal means of natural divination; for that which in these perceptions appeareth early, in the great effects cometh long after.'

There are a great many points of interest about this quotation, some of which will emerge into importance in succeeding lectures. In the first place, note the careful way in which Bacon discriminates between *perception,* or *taking account of,* on the one hand, and *sense,* or *cognitive experience,* on the other hand. In this respect Bacon is outside the physical line of thought which finally dominated the century. Later on, people thought of passive matter which was operated on externally by forces. I believe Bacon's line of thought to have expressed a more fundamental truth than do the materialistic concepts which were then being shaped as adequate for physics. We are now so used to the materialistic way of looking at things, which has been rooted in our literature by the genius of the seventeenth century, that it is with some difficulty that we understand

the possibility of another mode of approach to the problems of nature.

In the particular instance of the quotation which I have just made, the whole passage and the context in which it is embedded, are permeated through and through by the experimental method, that is to say, by attention to 'irreducible and stubborn facts,' and by the inductive method of eliciting general laws. Another unsolved problem which has been bequeathed to us by the seventeenth century is the rational justification of this method of Induction. The explicit realisation of the antithesis between the deductive rationalism of the scholastics and the inductive observational methods of the moderns must chiefly be ascribed to Bacon; though, of course, it was implicit in the mind of Galileo and of all the men of science of those times. But Bacon was one of the earliest of the whole group, and also had the most direct apprehension of the full extent of the intellectual revolution which was in progress. Perhaps the man who most completely anticipated both Bacon and the whole modern point of view was the artist Leonardo Da Vinci, who lived almost exactly a century before Bacon. Leonardo also illustrated the theory which I was advancing in my last lecture, that the rise of naturalistic art was an important ingredient in the formation of our scientific mentality. Indeed, Leonardo was more completely a man of science than was Bacon. The practice of naturalistic art is more akin to the practice of physics, chemistry and biology than is the practice of law. We all remember the saying of Bacon's contemporary, Harvey, the discoverer of the circulation of the blood, that Bacon 'wrote of science like a Lord Chancellor.' But at the beginning of the modern period Da Vinci and Bacon stand together as illustrating the various strains which have combined to form the modern world, namely, legal mentality and the patient observational habits of the naturalistic artists.

In the passage which I have quoted from Bacon's writings there is no explicit mention of the method of inductive reasoning. It is unnecessary for me to prove to you by any quotations that the enforcement of the importance of this method, and of the importance, to the welfare of mankind, of the secrets of nature to be thus discovered, was one of the main themes to which Bacon devoted himself in his writings. Induction has proved to be a somewhat more complex process than Bacon anticipated. He had in his mind the

belief that with a sufficient care in the collection of instances the general law would stand out of itself. We know now, and probably Harvey knew then, that this is a very inadequate account of the processes which issue in scientific generalisations. But when you have made all the requisite deductions, Bacon remains as one of the great builders who constructed the mind of the modern world.

The special difficulties raised by induction emerged in the eighteenth century, as the result of Hume's criticism. But Bacon was one of the prophets of the historical revolt, which deserted the method of unrelieved rationalism, and rushed into the other extreme of basing all fruitful knowledge upon inference from particular occasions in the past to particular occasions in the future. I do not wish to throw any doubt upon the validity of induction, when it has been properly guarded. My point is, that the very baffling task of applying reason to elicit the general characteristics of the immediate occasion, as set before us in direct cognition, is a necessary preliminary, if we are to justify induction; unless indeed we are content to base it upon our vague instinct that of course it is all right. Either there is something about the immediate occasion which affords knowledge of the past and the future, or we are reduced to utter scepticism as to memory and induction. It is impossible to over-emphasise the point that the key to the process of induction, as used either in science or in our ordinary life, is to be found in the right understanding of the immediate occasion of knowledge in its full concreteness. It is in respect to our grasp of the character of these occasions in their concreteness that the modern developments of physiology and of psychology are of critical importance. I shall illustrate this point in my subsequent lectures. We find ourselves amid insoluble difficulties when we substitute for this concrete occasion a mere abstract in which we only consider material objects in a flux of configurations in time and space. It is quite obvious that such objects can tell us only that they are where they are.

Accordingly, we must recur to the method of the school-divinity as explained by the Italian medievalists whom I quoted in the first lecture. We must observe the immediate occasion, and *use reason* to elicit a general description of its nature. Induction presupposes metaphysics. In other words, it rests upon an antecedent rationalism. You cannot have a rational justification for your appeal to history till your metaphysics has assured you that there *is* a history to appeal

to; and likewise your conjectures as to the future presuppose some basis of knowledge that there *is* a future already subjected to some determinations. The difficulty is to make sense of either of these ideas. But unless you have done so, you have made nonsense of induction.

You will observe that I do not hold induction to be in its essence the derivation of general laws. It is the divination of some characteristics of a particular future from the known characteristics of a particular past. The wider assumption of general laws holding for all cognisable occasions appears a very unsafe addendum to attach to this limited knowledge. All we can ask of the present occasion is that it shall determine a particular community of occasions, which are in some respects mutually qualified by reason of their inclusion within that same community. That community of occasions considered in physical science is the set of happenings which fit on to each other—as we say—in a common space-time, so that we can trace the transitions from one to the other. Accordingly, we refer to *the* common space-time indicated in our immediate occasion of knowledge. Inductive reasoning proceeds from the particular occasion to the particular community of occasions, and from the particular community to relations between particular occasions within that community. Until we have taken into account other scientific concepts, it is impossible to carry the discussion of induction further than this preliminary conclusion.

The third point to notice about this quotation from Bacon is the purely qualitative character of the statements made in it. In this respect Bacon completely missed the tonality which lay behind the success of seventeenth century science. Science was becoming, and has remained, primarily quantitative. Search for measurable elements among your phenomena, and then search for relations between these measures of physical quantities. Bacon ignores this rule of science. For example, in the quotation given he speaks of action at a distance; but he is thinking qualitatively and not quantitatively. We cannot ask that he should anticipate his younger contemporary Galileo, or his distant successor Newton. But he gives no hint that there should be a search for quantities. Perhaps he was misled by the current logical doctrines which had come down from Aristotle. For, in effect, these doctrines said to the physicist *classify* when they should have said *measure*.

By the end of the century physics had been founded on a satisfactory basis of measurement. The final and adequate exposition was given by Newton. The common measurable element of *mass* was discerned as characterising all bodies in different amounts. Bodies which are apparently identical in substance, shape, and size have very approximately the same mass: the closer the identity, the nearer the equality. The force acting on a body, whether by touch or by action at a distance, was [in effect] defined as being equal to the mass of the body multiplied by the rate of change of the body's velocity, so far as this rate of change is produced by that force. In this way the force is discerned by its effect on the motion of the body. The question now arises whether this conception of the magnitude of a force leads to the discovery of simple quantitative laws involving the alternative determination of forces by circumstances of the configuration of substances and of their physical characters. The Newtonian conception has been brilliantly successful in surviving this test throughout the whole modern period. Its first triumph was the law of gravitation. Its cumulative triumph has been the whole development of dynamical astronomy, of engineering, and of physics.

This subject of the formation of the three laws of motion and of the law of gravitation deserves critical attention. The whole development of thought occupied exactly two generations. It commenced with Galileo and ended with Newton's *Principia;* and Newton was born in the year that Galileo died. Also the lives of Descartes and Huyghens fall within the period occupied by these great terminal figures. The issue of the combined labours of these four men has some right to be considered as the greatest single intellectual success which mankind has achieved. In estimating its size, we must consider the completeness of its range. It constructs for us a vision of the material universe, and it enables us to calculate the minutest detail of a particular occurrence. Galileo took the first step in hitting on the right line of thought. He noted that the critical point to attend to was not the motion of bodies but the changes of their motions. Galileo's discovery is formularised by Newton in his first law of motion:—'Every body continues in its state of rest, or of uniform motion in a straight line, except so far as it may be compelled by force to change that state.'

This formula contains the repudiation of a belief which had

blocked the progress of physics for two thousand years. It also deals with a fundamental concept which is essential to scientific theory; I mean, the concept of an ideally isolated system. This conception embodies a fundamental character of things, without which science, or indeed any knowledge on the part of finite intellects, would be impossible. The 'isolated' system is not a solipsist system, apart from which there would be nonentity. It is isolated as within the universe. This means that there are truths respecting this system which require reference only to the remainder of things by way of a uniform systematic scheme of relationships. Thus the conception of an isolated system is not the conception of substantial independence from the remainder of things, but of freedom from casual contingent dependence upon detailed items within the rest of the universe. Further, this freedom from casual dependence is required only in respect to certain abstract characteristics which attach to the isolated system, and not in respect to the system in its full concreteness.

The first law of motion asks what is to be said of a dynamically isolated system so far as concerns its motion as a whole, abstracting from its orientation and its internal arrangement of parts. Aristotle said that you must conceive such a system to be at rest. Galileo added that the state of rest is only a particular case, and that the general statement is 'either in a state of rest, or of uniform motion in a straight line.' Accordingly, an Aristotelean would conceive the forces arising from the reaction of alien bodies as being quantitatively measurable in terms of the velocity they sustain, and as directively determined by the direction of that velocity; while the Galilean would direct attention to the magnitude of the acceleration and to its direction. This difference is illustrated by contrasting Kepler and Newton. They both speculated as to the forces sustaining the planets in their orbits. Kepler looked for tangential forces pushing the planets along, whereas Newton looked for radial forces diverting the directions of the planets' motions.

Instead of dwelling upon the mistake which Aristotle made, it is more profitable to emphasise the justification which he had for it, if we consider the obvious facts of our experience. All the motions which enter into our normal everyday experience cease unless they are evidently sustained from the outside. Apparently, therefore, the sound empiricist must devote his attention to this question of the sustenance of motion. We here hit upon one of the dangers of un-

imaginative empiricism. The seventeenth century exhibits another example of this same danger; and, of all people in the world, Newton fell into it. Huyghens had produced the wave theory of light. But this theory failed to account for the most obvious facts about light as in our ordinary experience, namely, that shadows cast by obstructing objects are defined by rectilinear rays. Accordingly, Newton rejected this theory and adopted the corpuscular theory which completely explained shadows. Since then both theories have had their periods of triumph. At the present moment the scientific world is seeking for a combination of the two. These examples illustrate the danger of refusing to entertain an idea because of its failure to explain one of the most obvious facts in the subject matter in question. If you have had your attention directed to the novelties in thought in your own lifetime, you will have observed that almost all really new ideas have a certain aspect of foolishness when they are first produced.

Returning to the laws of motion, it is noticeable that no reason was produced in the seventeenth century for the Galilean as distinct from the Aristotelian position. It was an ultimate fact. When in the course of these lectures we come to the modern period, we shall see that the theory of relativity throws complete light on this question; but only by rearranging our whole ideas as to space and time.

It remained for Newton to direct attention to *mass* as a physical quantity inherent in the nature of a material body. Mass remained permanent during all changes of motion. But the proof of the permanence of mass amid chemical transformations had to wait for Lavoisier, a century later. Newton's next task was to find some estimate of the magnitude of the alien force in terms of the mass of the body and of its acceleration. He here had a stroke of luck. For, from the point of view of a mathematician, the simplest possible law, namely the product of the two, proved to be the successful one. Again the modern relativity theory modifies this extreme simplicity. But luckily for science the delicate experiments of the physicists of to-day were not then known, or even possible. Accordingly, the world was given the two centuries which it required in order to digest Newton's laws of motion.

Having regard to this triumph, can we wonder that scientists placed their ultimate principles upon a materialistic basis, and there-

after ceased to worry about philosophy? We shall grasp the course of thought, if we understand exactly what this basis is, and what difficulties it finally involves. When you are criticising the philosophy of an epoch, do not chiefly direct your attention to those intellectual positions which its exponents feel it necessary explicitly to defend. There will be some fundamental assumptions which adherents of all the variant systems within the epoch unconsciously presuppose. Such assumptions appear so obvious that people do not know what they are assuming because no other way of putting things has ever occurred to them. With these assumptions a certain limited number of types of philosophic systems are possible, and this group of systems constitutes the philosophy of the epoch.

One such assumption underlies the whole philosophy of nature during the modern period. It is embodied in the conception which is supposed to express the most concrete aspect of nature. The Ionian philosophers asked, What is nature made of? The answer is couched in terms of stuff, or matter, or material—the particular name chosen is indifferent—which has the property of simple location in space and time, or, if you adopt the more modern ideas, in space-time. What I mean by matter, or material, is anything which has this property of *simple location*. By simple location I mean one major characteristic which refers equally both to space and to time, and other minor characteristics which are diverse as between space and time.

The characteristic common both to space and time is that material can be said to be *here* in space and *here* in time, or *here* in space-time, in a perfectly definite sense which does not require for its explanation any reference to other regions of space-time. Curiously enough this character of simple location holds whether we look on a region of space-time as determined absolutely or relatively. For if a region is merely a way of indicating a certain set of relations to other entities, then this characteristic, which I call simple location, is that material can be said to have just these relations of position to the other entities without requiring for its explanation any reference to other regions constituted by analogous relations of position to the same entities. In fact, as soon as you have settled, however you do settle, what you mean by a definite place in space-time, you can adequately state the relation of a particular material body to space-time by saying that it is just there, in that place; and,

so far as simple location is concerned, there is nothing more to be said on the subject.

There are, however, some subordinate explanations to be made which bring in the minor characteristics which I have already mentioned. First, as regards time, if material has existed during any period, it has equally been in existence during any portion of that period. In other words, dividing the time does not divide the material. Secondly, in respect to space, dividing the volume does divide the material. Accordingly, if material exists throughout a volume, there will be less of that material distributed through any definite half of that volume. It is from this property that there arises our notion of density at a point of space. Anyone who talks about density is not assimilating time and space to the extent that some extremists of the modern school of relativists very rashly desire. For the division of time functions, in respect to material, quite differently from the division of space.

Furthermore, this fact that the material is indifferent to the division of time leads to the conclusion that the lapse of time is an accident, rather than of the essense, of the material. The material is fully itself in any sub-period however short. Thus the transition of time has nothing to do with the character of the material. The material is equally itself at an instant of time. Here an instant of time is conceived as in itself without transition, since the temporal transition is the succession of instants.

The answer, therefore, which the seventeenth century gave to the ancient question of the Ionian thinkers, 'What is the world made of?' was that the world is a succession of instantaneous configurations of matter—or of material, if you wish to include stuff more subtle than ordinary matter, the ether for example.

We cannot wonder that science rested content with this assumption as to the fundamental elements of nature. The great forces of nature, such as gravitation, were entirely determined by the configurations of masses. Thus the configurations determined their own changes, so that the circle of scientific thought was completely closed. This is the famous mechanistic theory of nature, which has reigned supreme ever since the seventeenth century. It is the orthodox creed of physical science. Furthermore, the creed justified itself by the pragmatic test. It worked. Physicists took no more interest in philosophy. They emphasised the anti-rationalism of the Historical Revolt.

But the difficulties of this theory of materialistic mechanism very soon became apparent. The history of thought in the eighteenth and nineteenth centuries is governed by the fact that the world had got hold of a general idea which it could neither live with nor live without.

This simple location of instantaneous material configurations is what Bergson has protested against, so far as it concerns time and so far as it is taken to be the fundamental fact of concrete nature. He calls it a distortion of nature due to the intellectual 'spatialisation' of things. I agree with Bergson in his protest: but I do not agree that such distortion is a vice necessary to the intellectual apprehension of nature. I shall in subsequent lectures endeavour to show that this spatialisation is the expression of more concrete facts under the guise of very abstract logical constructions. There is an error; but it is merely the accidental error of mistaking the abstract for the concrete. It is an example of what I will call the 'Fallacy of Misplaced Concreteness.' This fallacy is the occasion of great confusion in philosophy. It is not necessary for the intellect to fall into the trap, though in this example there has been a very general tendency to do so.

It is at once evident that the concept of simple location is going to make great difficulties for induction. For, if in the location of configurations of matter throughout a stretch of time there is no inherent reference to any other times, past or future, it immediately follows that nature within any period does not refer to nature at any other period. Accordingly, induction is not based on anything which can be observed as inherent in nature. Thus we cannot look to nature for the justification of our belief in any law such as the law of gravitation. In other words, the order of nature cannot be justified by the mere observation of nature. For there is nothing in the present fact which inherently refers either to the past or to the future. It looks, therefore, as though memory, as well as induction, would fail to find any justification within nature itself.

I have been anticipating the course of future thought, and have been repeating Hume's argument. This train of thought follows so immediately from the consideration of simple location, that we cannot wait for the eighteenth century before considering it. The only wonder is that the world did in fact wait for Hume before noting the difficulty. Also it illustrates the anti-rationalism of the

scientific public that, when Hume did appear, it was only the religious implications of his philosophy which attracted attention. This was because the clergy were in principle rationalists, whereas the men of science were content with a simple faith in the order of nature. Hume himself remarks, no doubt scoffingly, 'Our holy religion is founded on faith.' This attitude satisfied the Royal Society but not the Church. It also satisfied Hume and has satisfied subsequent empiricists.

There is another presupposition of thought which must be put beside the theory of simple location. I mean the two correlative categories of substance and quality. There is, however, this difference. There were different theories as to the adequate description of the status of space. But whatever its status, no one had any doubt but that the connection with space enjoyed by entities, which are said to be in space, is that of simple location. We may put this shortly by saying that it was tacitly assumed that space is the locus of simple locations. Whatever is in space is *simpliciter* in some definite portion of space. But in respect to substance and quality the leading minds of the seventeenth century were definitely perplexed; though, with their usual genius, they at once constructed a theory which was adequate for their immediate purposes.

Of course, substance and quality, as well as simple location, are the most natural ideas for the human mind. It is the way in which we think of things, and without these ways of thinking we could not get our ideas straight for daily use. There is no doubt about this. The only question is, How concretely are we thinking when we consider nature under these conceptions? My point will be, that we are presenting ourselves with simplified editions of immediate matters of fact. When we examine the primary elements of these simplified editions, we shall find that they are in truth only to be justified as being elaborate logical constructions of a high degree of abstraction. Of course, as a point of individual psychology, we get at the ideas by the rough and ready method of suppressing what appear to be irrelevant details. But when we attempt to justify this suppression of irrelevance, we find that, though there are entities left corresponding to the entities we talk about, yet these entities are of a high degree of abstraction.

Thus I hold that substance and quality afford another instance of the fallacy of misplaced concreteness. Let us consider how the

notions of substance and quality arise. We observe an object as an entity with certain characteristics. Furthermore, each individual entity is apprehended through its characteristics. For example, we observe a body; there is something about it which we note. Perhaps, it is hard, and blue, and round, and noisy. We observe something which possesses these qualities: apart from these qualities we do not observe anything at all. Accordingly, the entity is the substratum, or substance, of which we predicate qualities. Some of the qualities are essential, so that apart from them the entity would not be itself; while other qualities are accidental and changeable. In respect to material bodies, the qualities of having a quantitative mass, and of simple location somewhere, were held by John Locke at the close of the seventeenth century to be essential qualities. Of course, the location was changeable, and the unchangeability of mass was merely an experimental fact except for some extremists.

So far, so good. But when we pass to blueness and noisiness a new situation has to be faced. In the first place, the body may not be always blue, or noisy. We have already allowed for this by our theory of accidental qualities, which for the moment we may accept as adequate. But in the second place, the seventeenth century exposed a real difficulty. The great physicists elaborated transmission theories of light and sound, based upon their materialistic views of nature. There were two hypotheses as to light: either it was transmitted by the vibratory waves of a materialistic ether, or—according to Newton—it was transmitted by the motion of incredibly small corpuscles of some subtle matter. We all know that the wave theory of Huyghens held the field during the nineteenth century, and at present physicists are endeavouring to explain some obscure circumstances attending radiation by a combination of both theories. But whatever theory you choose, there is no light or colour as a fact in external nature. There is merely motion of material. Again, when the light enters your eyes and falls on the retina, there is merely motion of material. Then your nerves are affected and your brain is affected, and again this is merely motion of material. The same line of argument holds for sound, substituting waves in the air for waves in the ether, and ears for eyes.

We then ask in what sense are blueness and noisiness qualities of the body. By analogous reasoning, we also ask in what sense is its scent a quality of the rose.

Galileo considered this question, and at once pointed out that, apart from eyes, ears, or noses, there would be no colours, sounds, or smells. Descartes and Locke elaborated a theory of primary and secondary qualities. For example, Descartes in his 'Sixth Meditation' says: * 'And indeed, as I perceive different sorts of colours, sounds, odours, tastes, heat, hardness, etc., I safely conclude that there are in the bodies from which the diverse perceptions of the senses proceed, certain varieties corresponding to them, although, perhaps, not in reality like them; . . .'

Also in his *Principles of Philosophy,* he says: 'That by our senses we know nothing of external objects beyond their figure [or situation], magnitude, and motion.'

Locke, writing with a knowledge of Newtonian dynamics, places mass among the primary qualities of bodies. In short, he elaborates a theory of primary and secondary qualities in accordance with the state of physical science at the close of the seventeenth century. The primary qualities are the essential qualities of substances whose spatio-temporal relationships constitute nature. The orderliness of these relationships constitutes the order of nature. The occurrences of nature are in some way apprehended by minds, which are associated with living bodies. Primarily, the mental apprehension is aroused by the occurrences in certain parts of the correlated body, the occurrences in the brain, for instance. But the mind in apprehending also experiences sensations which, properly speaking, are qualities of the mind alone. These sensations are projected by the mind so as to clothe appropriate bodies in external nature. Thus the bodies are perceived as with qualities which in reality do not belong to them, qualities which in fact are purely the offspring of the mind. Thus nature gets credit which should in truth be reserved for ourselves: the rose for its scent: the nightingale for his song: and the sun for his radiance. The poets are entirely mistaken. They should address their lyrics to themselves, and should turn them into odes of self-congratulation on the excellency of the human mind. Nature is a dull affair, soundless, scentless, colourless; merely the hurrying of material, endlessly, meaninglessly.

However you disguise it, this is the practical outcome of the characteristic scientific philosophy which closed the seventeenth century.

* Translation by Professor John Veitch.

In the first place, we must note its astounding efficiency as a system of concepts for the organisation of scientific research. In this respect, it is fully worthy of the genius of the century which produced it. It has held its own as the guiding principle of scientific studies ever since. It is still reigning. Every university in the world organises itself in accordance with it. No alternative system of organising the pursuit of scientific truth has been suggested. It is not only reigning, but it is without a rival.

And yet—it is quite unbelievable. This conception of the universe is surely framed in terms of high abstractions, and the paradox only arises because we have mistaken our abstraction for concrete realities.

No picture, however generalised, of the achievements of scientific thought in this century can omit the advance in mathematics. Here as elsewhere the genius of the epoch made itself evident. Three great Frenchmen, Descartes, Desargues, Pascal, initiated the modern period in geometry. Another Frenchman, Fermat, laid the foundations of modern analysis, and all but perfected the methods of the differential calculus. Newton and Leibniz, between them, actually did create the differential calculus as a practical method of mathematical reasoning. When the century ended, mathematics as an instrument for application to physical problems was well established in something of its modern proficiency. Modern pure mathematics, if we except geometry, was in its infancy, and had given no signs of the astonishing growth it was to make in the nineteenth century. But the mathematical physicist had appeared, bringing with him the type of mind which was to rule the scientific world in the next century. It was to be the age of 'Victorious Analysis.'

The seventeenth century had finally produced a scheme of scientific thought framed by mathematicians, for the use of mathematicians. The great characteristic of the mathematical mind is its capacity for dealing with abstractions; and for eliciting from them clear-cut demonstrative trains of reasoning, entirely satisfactory so long as it is those abstractions which you want to think about. The enormous success of the scientific abstractions, yielding on the one hand *matter* with its *simple location* in space and time, on the other hand *mind,* perceiving, suffering, reasoning, but not interfering, has foisted onto philosophy the task of accepting them as the most concrete rendering of fact.

Thereby, modern philosophy has been ruined. It has oscillated

in a complex manner between three extremes. There are the dualists, who accept matter and mind as on an equal basis, and the two varieties of monists, those who put mind inside matter, and those who put matter inside mind. But this juggling with abstractions can never overcome the inherent confusion introduced by the ascription of *misplaced concreteness* to the scientific scheme of the seventeenth century.

CHAPTER IV *THE EIGHTEENTH CENTURY*

In so far as the intellectual climates of different epochs can be contrasted, the eighteenth century in Europe was the complete antithesis to the Middle Ages. The contrast is symbolised by the difference between the cathedral of Chartres and the Parisian salons, where D'Alembert conversed with Voltaire. The Middle Ages were haunted with the desire to rationalise the infinite: the men of the eighteenth century rationalised the social life of modern communities, and based their sociological theories on an appeal to the facts of nature. The earlier period was the age of faith, based upon reason. In the later period, they let sleeping dogs lie: it was the age of reason, based upon faith. To illustrate my meaning:—St. Anselm would have been distressed if he had failed to find a convincing argument for the existence of God, and on this argument he based his edifice of faith, whereas Hume based his *Dissertation on the Natural History of Religion* upon his faith in the order of nature. In comparing these epochs it is well to remember that reason can err, and that faith may be misplaced.

In my previous lecture I traced the evolution, during the seventeenth century, of the scheme of scientific ideas which has dominated thought ever since. It involves a fundamental duality, with *material* on the one hand, and on the other hand *mind*. In between there lie the concepts of life, organism, function, instantaneous reality, interaction, order of nature, which collectively form the Achilles heel of the whole system.

I also express my conviction that if we desired to obtain a more fundamental expression of the concrete character of natural fact, the

element in this scheme which we should first criticise is the concept of *simple location.* In view therefore of the importance which this idea will assume in these lectures, I will repeat the meaning which I have attached to this phrase. To say that a bit of matter has *simple location* means that, in expressing its spatio-temporal relations, it is adequate to state that it is where it is, in a definite finite region of space, and throughout a definite finite duration of time, apart from any essential reference of the relations of that bit of matter to other regions of space and to other durations of time. Again, this concept of simple location is independent of the controversy between the absolutist and the relativist views of space or of time. So long as any theory of space, or of time, can give a meaning, either absolute or relative, to the idea of a definite region of space, and of a definite duration of time, the idea of simple location has a perfectly definite meaning. This idea is the very foundation of the seventeenth century scheme of nature. Apart from it, the scheme is incapable of expression. I shall argue that among the primary elements of nature as apprehended in our immediate experience, there is no element whatever which possesses this character of simple location. It does not follow, however, that the science of the seventeenth century was simply wrong. I hold that by a process of constructive abstraction we can arrive at abstractions which are the simply-located bits of material, and at other abstractions which are the minds included in the scientific scheme. Accordingly, the real error is an example of what I have termed: The Fallacy of Misplaced Concreteness.

The advantage of confining attention to a definite group of abstractions, is that you confine your thoughts to clear-cut definite things, with clear-cut definite relations. Accordingly, if you have a logical head, you can deduce a variety of conclusions respecting the relationships between these abstract entities. Furthermore, if the abstractions are well-founded, that is to say, if they do not abstract from everything that is important in experience, the scientific thought which confines itself to these abstractions will arrive at a variety of important truths relating to our experience of nature. We all know those clear-cut trenchant intellects, immovably encased in a hard shell of abstractions. They hold you to their abstractions by the sheer grip of personality.

The disadvantage of exclusive attention to a group of abstractions, however well-founded, is that, by the nature of the case, you

have abstracted from the remainder of things. In so far as the excluded things are important in your experience, your modes of thought are not fitted to deal with them. You cannot think without abstractions; accordingly, it is of the utmost importance to be vigilant in critically revising your *modes* of abstraction. It is here that philosophy finds its niche as essential to the healthy progress of society. It is the critic of abstractions. A civilisation which cannot burst through its current abstractions is doomed to sterility after a very limited period of progress. An active school of philosophy is quite as important for the locomotion of ideas, as is an active school of railway engineers for the locomotion of fuel.

Sometimes it happens that the service rendered by philosophy is entirely obscured by the astonishing success of a scheme of abstractions in expressing the dominant interests of an epoch. This is exactly what happened during the eighteenth century. *Les philosophes* were not philosophers. They were men of genius, clear-headed and acute, who applied the seventeenth century group of scientific abstractions to the analysis of the unbounded universe. Their triumph, in respect to the circle of ideas mainly interesting to their contemporaries, was overwhelming. Whatever did not fit into their scheme was ignored, derided, disbelieved. Their hatred of Gothic architecture symbolises their lack of sympathy with dim perspectives. It was the age of reason, healthy, manly, upstanding reason; but, of one-eyed reason, deficient in its vision of depth. We cannot overrate the debt of gratitude which we owe to these men. For a thousand years Europe had been a prey to intolerant, intolerable visionaries. The common sense of the eighteenth century, its grasp of the obvious facts of human suffering, and of the obvious demands of human nature, acted on the world like a bath of moral cleansing. Voltaire must have the credit, that he hated injustice, he hated cruelty, he hated senseless repression, and he hated hocus-pocus. Furthermore, when he saw them, he knew them. In these supreme virtues, he was typical of his century, on its better side. But if men cannot live on bread alone, still less can they do so on disinfectants. The age had its limitations; yet we cannot understand the passion with which some of its main positions are still defended, especially in the schools of science, unless we do full justice to its positive achievements. The seventeenth century scheme of concepts was proving a perfect instrument for research.

This triumph of materialism was chiefly in the sciences of rational dynamics, physics, and chemistry. So far as dynamics and physics were concerned, progress was in the form of direct developments of the main ideas of the previous epoch. Nothing fundamentally new was introduced, but there was an immense detailed development. Special cases were unravelled. It was as though the very Heavens were being opened, on a set plan. In the second half of the century, Lavoisier practically founded chemistry on its present basis. He introduced into it the principle that no material is lost or gained in any chemical transformations. This was the last success of materialistic thought, which has not ultimately proved to be double-edged. Chemical science now only waited for the atomic theory, in the next century.

In this century the notion of the mechanical explanation of all the processes of nature finally hardened into a dogma of science. The notion won through on its merits by reason of an almost miraculous series of triumphs achieved by the mathematical physicists, culminating in the *Méchanique Analytique* of Lagrange, which was published in 1787. Newton's *Principia* was published in 1687, so that exactly one hundred years separates the two great books. This century contains the first period of mathematical physics of the modern type. The publication of Clerk Maxwell's *Electricity and Magnetism* in 1873 marks the close of the second period. Each of these three books introduces new horizons of thought affecting everything which comes after them.

In considering the various topics to which mankind has bent its systematic thought, it is impossible not to be struck with the unequal distribution of ability among the different fields. In almost all subjects there are a few outstanding names. For it requires genius to create a subject as a distinct topic for thought. But in the case of many topics, after a good beginning very relevant to its immediate occasion, the subsequent development appears as a weak series of flounderings, so that the whole subject gradually loses its grip on the evolution of thought. It was far otherwise with mathematical physics. The more you study this subject, the more you will find yourself astonished by the almost incredible triumphs of intellect which it exhibits. The great mathematical physicists of the eighteenth and first few years of the nineteenth century, most of them French, are a case in point: Maupertuis, Clairaut, D'Alembert, Lagrange, Laplace, Fourier,

Carnot, form a series of names, such that each recalls to mind some achievement of the first rank. When Carlyle, as the mouthpiece of the subsequent Romantic Age, scoffingly terms the period the Age of Victorious Analysis, and mocks at Maupertuis as a 'sublimish gentleman in a white periwig,' he only exhibits the narrow side of the Romanticists whom he is then voicing.

It is impossible to explain intelligently, in a short time and without technicalities, the details of the progress made by this school. I will, however, endeavour to explain the main point of a joint achievement of Maupertuis and Lagrange. Their results, in conjunction with some subsequent mathematical methods due to two great German mathematicians of the first half of the nineteenth century, Gauss and Riemann, have recently proved themselves to be the preparatory work necessary for the new ideas which Herz and Einstein have introduced into mathematical physics. Also they inspired some of the best ideas in Clerk Maxwell's treatise, already mentioned in this lecture.

They aimed at discovering something more fundamental and more general than Newton's laws of motion which were discussed in the previous lecture. They wanted to find some wider ideas, and in the case of Lagrange some more general means of mathematical exposition. It was an ambitious enterprise, and they were completely successful. Maupertuis lived in the first half of the eighteenth century, and Lagrange's active life lay in its second half. We find in Maupertuis a tinge of the theologic age which preceded his birth. He started with the idea that the whole path of a material particle between any limits of time must achieve some perfection worthy of the providence of God. There are two points of interest in this motive principle. In the first place, it illustrates the thesis which I was urging in my first lecture that the way in which the medieval church had impressed on Europe the notion of the detailed providence of a rational personal God was one of the factors by which the trust in the order of nature had been generated. In the second place, though we are now all convinced that such modes of thought are of no direct use in detailed scientific enquiry, Maupertuis' success in this particular case shows that almost any idea which jogs you out of your current abstractions may be better than nothing. In the present case what the idea in question did for Maupertuis was to lead him to enquire what general property of the path as a whole could be deduced from Newton's laws of motion. Undoubtedly this was a very sensible procedure whatever

one's theological notions. Also his general idea led him to conceive that the property found would be a quantitative sum, such that any slight deviation from the path would increase it. In this supposition he was generalising Newton's first law of motion. For an isolated particle takes the shortest route with uniform velocity. So Maupertuis conjectured that a particle travelling through a field of force would realise the least possible amount of some quantity. He discovered such a quantity and called it the integral action between the time limits considered. In modern phraseology it is the sum through successive small lapses of time of the difference between the kinetic and potential energies of the particle at each successive instant. This action, therefore, has to do with the interchange between the energy arising from motion and the energy arising from position. Maupertuis had discovered the famous theorem of least action. Maupertuis was not quite of the first rank in comparison with such a man as Lagrange. In his hands and in those of his immediate successors, his principle did not assume any dominating importance. Lagrange put the same question on a wider basis so as to make its answer relevant to actual procedure in the development of dynamics. His Principle of Virtual Work as applied to systems in motion is in effect Maupertuis' principle conceived as applying at each instant of the path of the system. But Lagrange saw further than Maupertuis. He grasped that he had gained a method of stating dynamical truths in a way which is perfectly indifferent to the particular methods of measurement employed in fixing the positions of the various parts of the system. Accordingly, he went on to deduce equations of motion which are equally applicable whatever quantitative measurements have been made, provided that they are adequate to fix positions. The beauty and almost divine simplicity of these equations is such that these formulae are worthy to rank with those mysterious symbols which in ancient times were held directly to indicate the Supreme Reason at the base of all things. Later Herz—inventor of electromagnetic waves—based mechanics on the idea of every particle traversing the shortest path open to it under the circumstances constraining its motion; and finally Einstein, by the use of the geometrical theories of Gauss and Riemann, showed that these circumstances could be construed as being inherent in the character of space-time itself. Such, in barest outline, is the story of dynamics from Galileo to Einstein.

Meanwhile Galvani and Volta lived and made their electric dis-

coveries; and the biological sciences slowly gathered their material, but still waited for dominating ideas. Psychology, also, was beginning to disengage itself from its dependence on general philosophy. This independent growth of psychology was the ultimate result of its invocation by John Locke as a critic of metaphysical license. All the sciences dealing with life were still in an elementary observational stage, in which classification and direct description were dominant. So far the scheme of abstractions was adequate to the occasion.

In the realm of practice, the age which produced enlightened rulers, such as the Emperor Joseph of the House of Hapsburg, Frederick the Great, Walpole, the great Lord Chatham, George Washington, cannot be said to have failed. Especially when to these rulers, it adds the invention of parliamentary cabinet government in England, of federal presidential government in the United States, and of the humanitarian principles of the French Revolution. Also in technology it produced the steam-engine, and thereby ushered in a new era of civilisation. Undoubtedly, as a practical age the eighteenth century was a success. If you had asked one of the wisest and most typical of its ancestors, who just saw its commencement, I mean John Locke, what he expected from it he would hardly have pitched his hopes higher than its actual achievements.

In developing a criticism of the scientific scheme of the eighteenth century, I must first give my main reason for ignoring nineteenth century idealism—I am speaking of the philosophic idealism which finds the ultimate meaning of reality in mentality that is fully cognitive. This idealistic school, as hitherto developed, has been too much divorced from the scientific outlook. It has swallowed the scientific scheme in its entirety as being the only rendering of the facts of nature, and has then explained it as being an idea in the ultimate mentality. In the case of absolute idealism, the world of nature is just one of the ideas, somehow differentiating the unity of the Absolute: in the case of pluralistic idealism involving monadic mentalities, this world is the greatest common measure of the various ideas which differentiate the various mental unities of the various monads. But, however you take it, these idealistic schools have conspicuously failed to connect, in any organic fashion, the fact of nature with their idealistic philosophies. So far as concerns what will be said in these lectures, your ultimate outlook may be realistic or idealistic. My point is that a further stage of provisional realism is

required in which the scientific scheme is recast, and founded upon the ultimate concept of *organism*.

In outline, my procedure is to start from the analysis of the status of space and of time, or in modern phraseology, the status of space-time. There are two characters of either. Things are separated by space, and are separated by time: but they are also together in space, and together in time, even if they be not contemporaneous. I will call these characters the *separative* and the *prehensive* characters of space-time. There is yet a third character of space-time. Everything which is in space receives a definite limitation of some sort, so that in a sense it has just that shape which it does have and no other, also in some sense it is just in this place and in no other. Analogously for time, a thing endures during a certain period, and through no other period. I will call this the *modal* character of space-time. It is evident that the modal character taken by itself gives rise to the idea of simple location. But it must be conjoined with the separative and prehensive characters.

For simplicity of thought, I will first speak of space only, and will afterwards extend the same treatment to time.

The volume is the most concrete element of space. But the separative character of space, analyses a volume into sub-volumes, and so on indefinitely. Accordingly, taking the separative character in isolation, we should infer that a volume is a mere multiplicity of non-voluminous elements, of points in fact. But it is the unity of volume which is the ultimate fact of experience, for example, the voluminous space of this hall. This hall as a mere multiplicity of points is a construction of the logical imagination.

Accordingly, the prime fact is the prehensive unity of volume, and this unity is mitigated or limited by the separated unities of the innumerable contained parts. We have a prehensive unity, which is yet held apart as an aggregate of contained parts. But the prehensive unity of the volume is not the unity of a mere logical aggregate of parts. The parts form an ordered aggregate, in the sense that each part is something from the standpoint of every other part, and also from the same standpoint every other part is something in relation to it. Thus if A and B and C are volumes of space, B has an aspect from the standpoint of A, and so has C, and so has the relationship of B and C. This aspect of B from A is of the essence of A. The volumes of space have no independent existence. They are only entities

as within the totality; you cannot extract them from their environment without destruction of their very essence. Accordingly, I will say that the aspect of B from A is the *mode* in which B enters into the composition of A. This is the modal character of space, that the prehensive unity of A is the prehension into unity of the aspects of all other volumes from the standpoint of A. The shape of a volume is the formula from which the totality of its aspects can be derived. Thus the shape of a volume is more abstract than its aspects. It is evident that I can use Leibniz's language, and say that every volume mirrors in itself every other volume in space.

Exactly analogous considerations hold with respect to durations in time. An instant of time, without duration, is an imaginative logical construction. Also each duration of time mirrors in itself all temporal durations.

But in two ways I have introduced a false simplicity. In the first place, I should have conjoined space and time, and conducted my explanation in respect to four-dimensional regions of space-time. I have nothing to add in the way of explanation. In your minds, substitute such four-dimensional regions for the spatial volumes of the previous explanations.

Secondly, my explanation has involved itself in a vicious circle. For I have made the prehensive unity of the region A to consist of the prehensive unification of the modal presences in A of other regions. This difficulty arises because space-time cannot in reality be considered as a self-subsistent entity. It is an abstraction, and its explanation requires reference to that from which it has been extracted. Space-time is the specification of certain general characters of events and of their mutual ordering. This recurrence to concrete fact brings me back to the eighteenth century, and indeed to Francis Bacon in the seventeenth century. We have to consider the development in those epochs, of the criticism of the reigning scientific scheme.

No epoch is homogeneous; whatever you may have assigned as the dominant note of a considerable period, it will always be possible to produce men, and great men, belonging to the same time, who exhibit themselves as antagonistic to the tone of their age. This is certainly the case with the eighteenth century. For example, the names of John Wesley and of Rousseau must have occurred to you while I was drawing the character of that time. But I do not want to speak of them, or of others. The man whose ideas I must consider at some

length is Bishop Berkeley. Quite at the commencement of the epoch, he made all the right criticisms, at least in principle. It would be untrue to say that he produced no effect. He was a famous man. The wife of George II was one of the few queens who, in any country, have been clever enough, and wise enough, to patronise learning judiciously; accordingly, Berkeley was made a bishop, in days when bishops in Great Britain were relatively far greater men than they are now. Also, what was more important than his bishopric, Hume studied him, and developed one side of his philosophy in a way which might have disturbed the ghost of the great ecclesiastic. Then Kant studied Hume. So, to say that Berkeley was uninfluential during the century, would certainly be absurd. But all the same, he failed to affect the main stream of scientific thought. It flowed on as if he had never written. Its general success made it impervious to criticism, then and since. The world of science has always remained perfectly satisfied with its peculiar abstractions. They work, and that is sufficient for it.

The point before us is that this scientific field of thought is now, in the twentieth century, too narrow for the concrete facts which are before it for analysis. This is true even in physics, and is more especially urgent in the biological sciences. Thus, in order to understand the difficulties of modern scientific thought and also its reactions on the modern world, we should have in our minds some conception of a wider field of abstraction, a more concrete analysis, which shall stand nearer to the complete concreteness of our intuitive experience. Such an analysis should find in itself a niche for the concepts of matter and spirit, as abstractions in terms of which much of our physical experience can be interpreted. It is in the search for this wider basis for scientific thought that Berkeley is so important. He launched his criticism shortly after the schools of Newton and Locke had completed their work, and laid his finger exactly on the weak spots which they had left. I do not propose to consider either the subjective idealism which has been derived from him, or the schools of development which trace their descent from Hume and Kant respectively. My point will be that—whatever the final metaphysics you may adopt—there is another line of development embedded in Berkeley, pointing to the analysis which we are in search of. Berkeley overlooked it, partly by reason of the overintellectualism of philosophers, and partly by his haste to have recourse to an idealism with

its objectivity grounded in the mind of God. You will remember that I have already stated that the key of the problem lies in the notion of simple location. Berkeley, in effect, criticises this notion. He also raises the question, What do we mean by things being realised in the world of nature?

In Sections 23 and 24 of his *Principles of Human Knowledge,* Berkeley gives his answer to this latter question. I will quote some detached sentences from those Sections:

'23. But, say you, surely there is nothing easier than for me to imagine trees, for instance, in a park, or books existing in a closet, and nobody by to perceive them. I answer, you may so, there is no difficulty in it; but what is all this, I beseech you, more than framing in your mind certain ideas which you call books and trees, and at the same time omitting to frame the idea of any one that may perceive them? . . .

'When we do our utmost to conceive the existence of external bodies, we are all the while only contemplating our own ideas. But the mind *taking no notice of itself,* is deluded to think it can and does conceive bodies existing unthought of or without the mind, though at the same time they are apprehended by or exist in itself. . . .

'24. It is very obvious, upon the least inquiry into our thoughts, to know whether it be possible for us to understand what is meant by the *absolute existence of sensible objects in themselves, or without the mind.* To me it is evident those words mark out either a direct contradiction, or else nothing at all. . . .'

Again there is a very remarkable passage in Section 10, of the fourth Dialogue of Berkeley's *Alciphron.* I have already quoted it, at greater length, in my *Principles of Natural Knowledge:*

'*Euphranor.* Tell me, Alciphron, can you discern the doors, window and battlements of that same castle?

'*Alciphron.* I cannot. At this distance it seems only a small round tower.

'*Euph.* But I, who have been at it, know that it is no small round tower, but a large square building with battlements and turrets, which it seems you do not see.

'*Alc.* What will you infer from thence?

'*Euph.* I would infer that the very object which you strictly and

properly perceive by sight is not that thing which is several miles distant.

'*Alc.* Why so?

'*Euph.* Because a little round object is one thing, and a great square object is another. Is it not so? . . .'

Some analogous examples concerning a planet and a cloud are then cited in the dialogue, and this passage finally concludes with:

'*Euphranor.* Is it not plain, therefore, that neither the castle, the planet, nor the cloud, *which you see here,* are those real ones which you suppose exist at a distance?'

It is made explicit in the first passage, already quoted, that Berkeley himself adopts an extreme idealistic interpretation. For him mind is the only absolute reality, and the unity of nature is the unity of ideas in the mind of God. Personally, I think that Berkeley's solution of the metaphysical problem raises difficulties not less than those which he points out as arising from a realistic interpretation of the scientific scheme. There is, however, another possible line of thought, which enables us to adopt anyhow an attitude of provisional realism, and to widen the scientific scheme in a way which is useful for science itself.

I recur to the passage from Francis Bacon's *Natural History,* already quoted in the previous lecture:

'It is certain that all bodies whatsoever, though they have no sense, yet they have perception: . . . and whether the body be alterant or altered, evermore a perception precedeth operation; for else all bodies would be alike one to another. . . .'

Also in the previous lecture I construed *perception* (as used by Bacon) as meaning *taking account of* the essential character of the thing perceived, and I construed *sense* as meaning *cognition.* We certainly do take account of things of which at the time we have no explicit cognition. We can even have a cognitive memory of the taking account, without having had a contemporaneous cognition. Also, as Bacon points out by his statement, '. . . for else all bodies would be alike one to another,' it is evidently some element of the essential character which we take account of, namely something on which diversity is founded and not mere bare logical diversity.

The word *perceive* is, in our common usage, shot through and through with the notion of cognitive apprehension. So is the word

apprehension, even with the adjective *cognitive* omitted. I will use the word *prehension* for *uncognitive apprehension:* by this I mean *apprehension* which may or may not be cognitive. Now take Euphranor's last remark:

'Is it not plain, therefore, that neither the castle, the planet, nor the cloud, *which you see here,* are those real ones which you suppose exist at a distance?' Accordingly, there is a prehension, *here* in this place, of things which have a reference to *other* places.

Now go back to Berkeley's sentences, quoted from his *Principles of Human Knowledge.* He contends that what constitutes the realisation of natural entities is the being perceived within the unity of mind.

We can substitute the concept, that the realisation is a gathering of things into the unity of a prehension; and that what is thereby realised is the prehension, and not the things. This unity of a prehension defines itself as a *here* and a *now,* and the things so gathered into the grasped unity have essential reference to other places and other times. For Berkeley's *mind,* I substitute a process of prehensive unification. In order to make intelligible this concept of the progressive realisation of natural occurrences, considerable expansion is required, and confrontation with its actual implications in terms of concrete experience. This will be the task of the subsequent lectures. In the first place, note that the idea of simple location has gone. The things which are grasped into a realised unity, here and now, are not the castle, the cloud, and the planet simply in themselves; but they are the castle, the cloud, and the planet from the standpoint, in space and time, of the prehensive unification. In other words, it is the perspective of the castle over there from the standpoint of the unification here. It is, therefore, aspects of the castle, the cloud, and the planet which are grasped into unity here. You will remember that the idea of perspectives is quite familiar in philosophy. It was introduced by Leibniz, in the notion of his monads mirroring perspectives of the universe. I am using the same notion, only I am toning down his monads into the unified events in space and time. In some ways, there is a greater analogy with Spinoza's modes; that is why I use the terms *mode* and *modal.* In the analogy with Spinoza, his one substance is for me the one underlying activity of realisation individualising itself in an interlocked plurality of modes. Thus, concrete fact is process. Its primary analysis is into underlying activity of prehension, and into realised prehensive events. Each event

is an individual matter of fact issuing from an individualisation of the substrate activity. But individualisation does not mean substantial independence.

An entity of which we become aware in sense perception is the terminus of our act of perception. I will call such an entity, a *sense-object*. For example, green of a definite shade is a sense-object; so is a sound of definite quality and pitch; and so is a definite scent; and a definite quality of touch. The way in which such an entity is related to space during a definite lapse of time is complex. I will say that a sense-object has *ingression* into space-time. The cognitive perception of a sense-object is the awareness of the prehensive unification (into a standpoint A) of various modes of various sense-objects, including the sense-object in question. The standpoint A is, of course, a region of space-time; that is to say, it is a volume of space through a duration of time. But as one entity, this standpoint is a unit of realised experience. A mode of a sense-object at A (as abstracted from the sense-object whose relationship to A the mode is conditioning) is the aspect from A of some other region B. Thus the sense-object is present in A with the mode of location in B. Thus if green be the sense-object in question, green is not simply at A where it is being perceived, nor is it simply at B where it is perceived as located; but it is present at A with the mode of location in B. There is no particular mystery about this. You have only got to look into a mirror and to see the image in it of some green leaves behind your back. For you at A there will be green; but not green simply at A where you are. The green at A will be green with the mode of having location at the image of the leaf behind the mirror. Then turn round and look at the leaf. You are now perceiving the green in the same way as you did before, except that now the green has the mode of being located in the actual leaf. I am merely describing what we do perceive: we are aware of green as being one element in a prehensive unification of sense-objects; each sense-object, and among them green, having its particular mode, which is expressible as location elsewhere. There are various types of modal location. For example, sound is voluminous: it fills a hall, and so sometimes does diffused colour. But the modal location of a colour may be that of being the remote boundary of a volume, as for example the colours on the walls of a room. Thus primarily space-time is the locus of the modal ingression of sense-objects. This is the reason why space and time (if for sim-

plicity we disjoin them) are given in their entireties. For each volume of space, or each lapse of time, includes in its essence aspects of all volumes of space, or of all lapses of time. The difficulties of philosophy in respect to space and time are founded on the error of considering them as primarily the loci of simple locations. Perception is simply the cognition of prehensive unification; or more shortly, perception is cognition of prehension. The actual world is a manifold of prehensions; and a 'prehension' is a 'prehensive occasion'; and a prehensive occasion is the most concrete finite entity, conceived as what it is in itself and for itself, and not as from its aspect in the essence of another such occasion. Prehensive unification might be said to have simple location in its volume A. But this would be a mere tautology. For space and time are simply abstractions from the totality of prehensive unifications as mutually patterned in each other. Thus a prehension has simple location at the volume A in the same way as that in which a man's face fits on to the smile which spreads over it. There is, so far as we have gone, more sense in saying that an act of perception has simple location; for it may be conceived as being simply at the cognised prehension.

There are more entities involved in nature than the mere sense-objects, so far considered. But, allowing for the necessity of revision consequent on a more complete point of view, we can frame our answer to Berkeley's question as to the character of the reality to be assigned to nature. He states it to be the reality of ideas in mind. A complete metaphysic which has attained to some notion of mind, and to some notion of ideas, may perhaps ultimately adopt that view. It is unnecessary for the purpose of these lectures to ask such a fundamental question. We can be content with a provisional realism in which nature is conceived as a complex of prehensive unifications. Space and time exhibit the general scheme of interlocked relations of these prehensions. You cannot tear any one of them out of its context. Yet each one of them within its context has all the reality that attaches to the whole complex. Conversely, the totality has the same reality as each prehension; for each prehension unifies the modalities to be ascribed, from its standpoint, to every part of the whole. A prehension is a process of unifying. Accordingly, nature is a process of expansive development, necessarily transitional from prehension to prehension. What is achieved is thereby passed beyond,

but it is also retained as having aspects of itself present to prehensions which lie beyond it.

Thus nature is a structure of evolving processes. The reality is the process. It is nonsense to ask if the colour red is real. The colour red is ingredient in the process of realisation. The realities of nature are the prehensions in nature, that is to say, the events in nature.

Now that we have cleared space and time from the taint of simple location, we may partially abandon the awkward term prehension. This term was introduced to signify the essential unity of an event, namely, the event as one entity, and not as a mere assemblage of parts or of ingredients. It is necessary to understand that space-time is nothing else than a system of pulling together of assemblages into unities. But the word *event* just means one of these spatio-temporal unities. Accordingly, it may be used instead of the term 'prehension' as meaning the thing prehended.

An event has contemporaries. This means that an event mirrors within itself the modes of its contemporaries as a display of immediate achievement. An event has a past. This means that an event mirrors within itself the modes of its predecessors, as memories which are fused into its own content. An event has a future. This means that an event mirrors within itself such aspects as the future throws back on to the present, or, in other words, as the present has determined concerning the future. Thus an event has anticipation:

> 'The prophetic soul
> Of the wide world dreaming on things to come.'

These conclusions are essential for any form of realism. For there is in the world for our cognisance, memory of the past, immediacy of realisation, and indication of things to come.

In this sketch of an analysis more concrete than that of the scientific scheme of thought, I have started from our own psychological field, as it stands for our cognition. I take it for what it claims to be: the self-knowledge of our bodily event. I mean the total event, and not the inspection of the details of the body. This self-knowledge discloses a prehensive unification of modal presences of entities beyond itself. I generalise by the use of the principle that this total bodily event is on the same level as all other events, except for an unusual complexity and stability of inherent pattern. The strength of the theory

of materialistic mechanism has been the demand, that no arbitrary breaks be introduced into nature, to eke out the collapse of an explanation. I accept this principle. But if you start from the immediate facts of our psychological experience, as surely an empiricist should begin, you are at once led to the organic conception of nature of which the description has been commenced in this lecture.

It is the defect of the eighteenth century scientific scheme that it provides none of the elements which compose the immediate psychological experiences of mankind. Nor does it provide any elementary trace of the organic unity of a whole, from which the organic unities of electrons, protons, molecules, and living bodies can emerge. According to that scheme, there is no reason in the nature of things why portions of material should have any physical relations to each other. Let us grant that we cannot hope to be able to discern the laws of nature to be necessary. But we can hope to see that it is necessary that there should be an order of nature. The concept of the order of nature is bound up with the concept of nature as the locus of organisms in process of development.

NOTE. In connection with the latter portion of this chapter a sentence from Descartes' 'Reply to Objections . . . against the Meditations' is interesting:—'Hence the idea of the sun will be the sun itself existing in the mind, not indeed formally, as it exists in the sky, but objectively, *i.e.*, in the way in which objects are wont to exist in the mind; and this mode of being is truly much less perfect than that in which things exist outside the mind, but it is not on that account mere nothing, as I have already said.' [Reply to Objections I, Trans. by Haldane and Ross, vol. ii, p. 10.] I find difficulty in reconciling this theory of ideas (with which I agree) with other parts of the Cartesian philosophy.

CHAPTER V *THE ROMANTIC REACTION*

My last lecture described the influence upon the eighteenth century of the narrow and efficient scheme of scientific concepts which it had inherited from its predecessor. That scheme was the product of a mentality which found the Augustinian theology extremely congenial. The Protestant Calvinism and the Catholic Jansenism exhibited man as helpless to co-operate with Irresistible Grace: the contemporary scheme of science exhibited man as helpless to co-operate with the irresistible mechanism of nature. The mechanism of God and the

mechanism of matter were the monstrous issues of limited metaphysics and clear logical intellect. Also the seventeenth century had genius, and cleared the world of muddled thought. The eighteenth century continued the work of clearance, with ruthless efficiency. The scientific scheme has lasted longer than the theological scheme. Mankind soon lost interest in Irresistible Grace; but it quickly appreciated the competent engineering which was due to science. Also in the first quarter of the eighteenth century, George Berkeley launched his philosophical criticism against the whole basis of the system. He failed to disturb the dominant current of thought. In my last lecture I developed a parallel line of argument, which would lead to a system of thought basing nature upon the concept of organism, and not upon the concept of matter. In the present lecture, I propose in the first place to consider how the concrete educated thought of men has viewed this opposition of mechanism and organism. It is in literature that the concrete outlook of humanity receives its expression. Accordingly it is to literature that we must look, particularly in its more concrete forms, namely in poetry and in drama, if we hope to discover the inward thoughts of a generation.

We quickly find that the Western peoples exhibit on a colossal scale a peculiarity which is popularly supposed to be more especially characteristic of the Chinese. Surprise is often expressed that a Chinaman can be of two religions, a Confucian for some occasions and a Buddhist for other occasions. Whether this is true of China I do not know; nor do I know whether, if true, these two attitudes are really inconsistent. But there can be no doubt that an analogous fact is true of the West, and that the two attitudes involved are inconsistent. A scientific realism, based on mechanism, is conjoined with an unwavering belief in the world of men and of the higher animals as being composed of self-determining organisms. This radical inconsistency at the basis of modern thought accounts for much that is half-hearted and wavering in our civilisation. It would be going too far to say that it distracts thought. It enfeebles it, by reason of the inconsistency lurking in the background. After all, the men of the Middle Ages were in pursuit of an excellency of which we have nearly forgotten the existence. They set before themselves the ideal of the attainment of a harmony of the understanding. We are content with superficial orderings from diverse arbitrary starting points. For instance, the enterprises produced by the individualistic energy of

the European peoples presuppose physical actions directed to final causes. But the science which is employed in their development is based on a philosophy which asserts that physical causation is supreme, and which disjoins the physical cause from the final end. It is not popular to dwell on the absolute contradiction here involved. It is the fact, however you gloze it over with phrases. Of course, we find in the eighteenth century Paley's famous argument, that mechanism presupposes a God who is the author of nature. But even before Paley put the argument into its final form, Hume had written the retort, that the God whom you will find will be the sort of God who makes that mechanism. In other words, that mechanism can, at most, presuppose a mechanic, and not merely *a* mechanic but *its* mechanic. The only way of mitigating mechanism is by the discovery that it is not mechanism.

When we leave apologetic theology, and come to ordinary literature, we find, as we might expect, that the scientific outlook is in general simply ignored. So far as the mass of literature is concerned, science might never have been heard of. Until recently nearly all writers have been soaked in classical and renaissance literature. For the most part, neither philosophy nor science interested them, and their minds were trained to ignore them.

There are exceptions to this sweeping statement; and, even if we confine ourselves to English literature, they concern some of the greatest names; also the indirect influence of science has been considerable.

A side light on this distracting inconsistency in modern thought is obtained by examining some of those great serious poems in English literature, whose general scale gives them a didactic character. The relevant poems are Milton's *Paradise Lost,* Pope's *Essay on Man,* Wordsworth's *Excursion,* Tennyson's *In Memoriam.* Milton, though he is writing after the Restoration, voices the theological aspect of the earlier portion of his century, untouched by the influence of the scientific materialism. Pope's poem represents the effect on popular thought of the intervening sixty years which includes the first period of assured triumph for the scientific movement. Wordsworth in his whole being expresses a conscious reaction against the mentality of the eighteenth century. This mentality means nothing else than the acceptance of the scientific ideas at their full face value. Words-

worth was not bothered by any intellectual antagonism. What moved him was a moral repulsion. He felt that something had been left out, and that what had been left out comprised everything that was most important. Tennyson is the mouthpiece of the attempts of the waning romantic movement in the second quarter of the nineteenth century to come to terms with science. By this time the two elements in modern thought had disclosed their fundamental divergence by their jarring interpretations of the course of nature and the life of man. Tennyson stands in this poem as the perfect example of the distraction which I have already mentioned. There are opposing visions of the world, and both of them command his assent by appeals to ultimate intuitions from which there seems no escape. Tennyson goes to the heart of the difficulty. It is the problem of mechanism which appalls him,

' "The stars," she whispers, "blindly run." '

This line states starkly the whole philosophic problem implicit in the poem. Each molecule blindly runs. The human body is a collection of molecules. Therefore, the human body blindly runs, and therefore there can be no individual responsibility for the actions of the body. If you once accept that the molecule is definitely determined to be what it is, independently of any determination by reason of the total organism of the body, and if you further admit that the blind run is settled by the general mechanical laws, there can be no escape from this conclusion. But mental experiences are derivative from the actions of the body, including of course its internal behaviour. Accordingly, the sole function of the mind is to have at least some of its experiences settled for it, and to add such others as may be open to it independently of the body's motions, internal and external.

There are then two possible theories as to the mind. You can either deny that it can supply for itself any experiences other than those provided for it by the body, or you can admit them.

If you refuse to admit the additional experiences, then all individual moral responsibility is swept away. If you do admit them, then a human being may be responsible for the state of his mind though he has no responsibility for the actions of his body. The enfeeblement of thought in the modern world is illustrated by the way in which this plain issue is avoided in Tennyson's poem. There is something kept

in the background, a skeleton in the cupboard. He touches on almost every religious and scientific problem, but carefully avoids more than a passing allusion to this one.

This very problem was in full debate at the date of the poem. John Stuart Mill was maintaining his doctrine of determinism. In this doctrine volitions are determined by motives, and motives are expressible in terms of antecedent conditions including states of mind as well as states of the body.

It is obvious that this doctrine affords no escape from the dilemma presented by a thoroughgoing mechanism. For if the volition affects the state of the body, then the molecules in the body do not blindly run. If the volition does not affect the state of the body, the mind is still left in its uncomfortable position.

Mill's doctrine is generally accepted, especially among scientists, as though in some way it allowed you to accept the extreme doctrine of materialistic mechanism, and yet mitigated its unbelievable consequences. It does nothing of the sort. Either the bodily molecules blindly run, or they do not. If they do blindly run, the mental states are irrelevant in discussing the bodily actions.

I have stated the arguments concisely, because in truth the issue is a very simple one. Prolonged discussion is merely a source of confusion. The question as to the metaphysical status of molecules does not come in. The statement that they are mere formulae has no bearing on the argument. For presumably the formulae mean something. If they mean nothing, the whole mechanical doctrine is likewise without meaning, and the question drops. But if the formulae mean anything, the argument applies to exactly what they do mean. The traditional way of evading the difficulty—other than the simple way of ignoring it—is to have recourse to some form of what is now termed 'vitalism.' This doctrine is really a compromise. It allows a free run to mechanism throughout the whole of inanimate nature, and holds that the mechanism is partially mitigated within living bodies. I feel that this theory is an unsatisfactory compromise. The gap between living and dead matter is too vague and problematical to bear the weight of such an arbitrary assumption, which involves an essential dualism somewhere.

The doctrine which I am maintaining is that the whole concept of materialism only applies to very abstract entities, the products of logical discernment. The concrete enduring entities are organisms, so

that the plan of the *whole* influences the very characters of the various subordinate organisms which enter into it. In the case of an animal, the mental states enter into the plan of the total organism and thus modify the plans of the successive subordinate organisms until the ultimate smallest organisms, such as electrons, are reached. Thus an electron within a living body is different from an electron outside it, by reason of the plan of the body. The electron blindly runs either within or without the body; but it runs within the body in accordance with its character within the body; that is to say, in accordance with the general plan of the body, and this plan includes the mental state. But the principle of modification is perfectly general throughout nature, and represents no property peculiar to living bodies. In subsequent lectures it will be explained that this doctrine involves the abandonment of the traditional scientific materialism, and the substitution of an alternative doctrine of organism.

I shall not discuss Mill's determinism, as it lies outside the scheme of these lectures. The foregoing discussion has been directed to secure that either determinism or free will shall have some relevance, unhampered by the difficulties introduced by materialistic mechanism, or by the compromise of vitalism. I would term the doctrine of these lectures, the theory of *organic mechanism*. In this theory, the molecules may blindly run in accordance with the general laws, but the molecules differ in their intrinsic characters according to the general organic plans of the situations in which they find themselves.

The discrepancy between the materialistic mechanism of science and the moral intuitions, which are presupposed in the concrete affairs of life, only gradually assumed its true importance as the centuries advanced. The different tones of the successive epochs to which the poems, already mentioned, belong are curiously reflected in their opening passages. Milton ends his introduction with the prayer,

> 'That to the height of this great argument
> I may assert eternal Providence,
> And justify the ways of God to men.'

To judge from many modern writers on Milton, we might imagine that the *Paradise Lost* and the *Paradise Regained* were written as a series of experiments in blank verse. This was certainly not Milton's view of his work. To 'justify the ways of God to men' was very much his main object. He recurs to the same idea in the *Samson Agonistes,*

'Just are the ways of God
And justifiable to men.'

We note the assured volume of confidence, untroubled by the coming scientific avalanche. The actual date of the publication of the *Paradise Lost* lies just beyond the epoch to which it belongs. It is the swan-song of a passing world of untroubled certitude.

A comparison between Pope's *Essay on Man* and the *Paradise Lost* exhibits the change of tone in English thought in the fifty or sixty years which separate the age of Milton from the age of Pope. Milton addresses his poem to God, Pope's poem is addressed to Lord Bolingbroke,

'Awake, my St. John! leave all meaner things
To low ambition and the pride of kings.
Let us (since life can little more supply
Than just to look about us and to die)
Expatiate free o'er all this scene of man;
A mighty maze! but not without a plan.'

Compare the jaunty assurance of Pope,

'A mighty maze! but not without a plan,'

with Milton's

'Just are the ways of God
And justifiable to men.'

But the real point to notice is that Pope as well as Milton was untroubled by the great perplexity which haunts the modern world. The clue which Milton followed was to dwell on the ways of God in dealings with man. Two generations later we find Pope equally confident that the enlightened methods of modern science provided a plan adequate as a map of the 'mighty maze.'

Wordsworth's *Excursion* is the next English poem on the same subject. A prose preface tells us that it is a fragment of a larger projected work, described as 'A philosophical poem containing views of Man, Nature, and Society.'

Very characteristically the poem begins with the line,

' 'Twas summer, and the sun had mounted high.'

Thus the romantic reaction started neither with God nor with Lord Bolingbroke, but with nature. We are here witnessing a conscious

reaction against the whole tone of the eighteenth century. That century approached nature with the abstract analysis of science, whereas Wordsworth opposes to the scientific abstractions his full concrete experience.

A generation of religious revival and of scientific advance lies between the *Excursion* and Tennyson's *In Memoriam*. The earlier poets had solved the perplexity by ignoring it. That course was not open to Tennyson. Accordingly his poem begins thus:

> 'Strong Son of God, immortal Love,
> Whom we, that have not seen Thy face,
> By faith, and faith alone, embrace,
> Believing where we cannot prove.'

The note of perplexity is struck at once. The nineteenth century has been a perplexed century, in a sense which is not true of any of its predecessors of the modern period. In the earlier times there were opposing camps, bitterly at variance on questions which they deemed fundamental. But, except for a few stragglers, either camp was wholehearted. The importance of Tennyson's poem lies in the fact that it exactly expressed the character of its period. Each individual was divided against himself. In the earlier times, the deep thinkers were the clear thinkers,—Descartes, Spinoza, Locke, Leibniz. They knew exactly what they meant and said it. In the nineteenth century, some of the deeper thinkers among theologians and philosophers were muddled thinkers. Their assent was claimed by incompatible doctrines; and their efforts at reconciliation produced inevitable confusion.

Matthew Arnold, even more than Tennyson, was the poet who expressed this mood of individual distraction which was so characteristic of this century. Compare with *In Memoriam* the closing lines of Arnold's *Dover Beach:*

> 'And we are here as on a darkling plain
> Swept with confused alarms of struggle and flight,
> Where ignorant armies clash by night.'

Cardinal Newman in his *Apologia pro Vita Sua* mentions it as a peculiarity of Pusey, the great Anglican ecclesiastic, 'He was haunted by no intellectual perplexities.' In this respect Pusey recalls Milton, Pope, Wordsworth, as in contrast with Tennyson, Clough, Matthew Arnold, and Newman himself.

So far as concerns English literature we find, as might be anticipated, the most interesting criticism of the thoughts of science among the leaders of the romantic reaction which accompanied and succeeded the epoch of the French Revolution. In English literature, the deepest thinkers of this school were Coleridge, Wordsworth, and Shelley. Keats is an example of literature untouched by science. We may neglect Coleridge's attempt at an explicit philosophical formulation. It was influential in his own generation; but in these lectures it is my object only to mention those elements of the thought of the past which stand for all time. Even with this limitation, only a selection is possible. For our purposes Coleridge is only important by his influence on Wordsworth. Thus Wordsworth and Shelley remain.

Wordsworth was passionately absorbed in nature. It has been said of Spinoza, that he was drunk with God. It is equally true that Wordsworth was drunk with nature. But he was a thoughtful, well-read man, with philosophical interests, and sane even to the point of prosiness. In addition, he was a genius. He weakens his evidence by his dislike of science. We all remember his scorn of the poor man whom he somewhat hastily accuses of peeping and botanising on his mother's grave. Passage after passage could be quoted from him, expressing this repulsion. In this respect, his characteristic thought can be summed up in his phrase, 'We murder to dissect.'

In this latter passage, he discloses the intellectual basis of his criticism of science. He alleges against science its absorption in abstractions. His consistent theme is that the important facts of nature elude the scientific method. It is important therefore to ask, what Wordsworth found in nature that failed to receive expression in science. I ask this question in the interest of science itself; for one main position in these lectures is a protest against the idea that the abstractions of science are irreformable and unalterable. Now it is emphatically not the case that Wordsworth hands over inorganic matter to the mercy of science, and concentrates on the faith that in the living organism there is some element that science cannot analyse. Of course he recognises, what no one doubts, that in some sense living things are different from lifeless things. But that is not his main point. It is the brooding presence of the hills which haunts him. His theme is nature *in solido,* that is to say, he dwells on that mysterious presence of surrounding things, which imposes itself on any

separate element that we set up as an individual for its own sake. He always grasps the whole of nature as involved in the tonality of the particular instance. That is why he laughs with the daffodils, and finds in the primrose thoughts 'too deep for tears.'

Wordsworth's greatest poem is, by far, the first book of *The Prelude*. It is pervaded by this sense of the haunting presences of nature. A series of magnificent passages, too long for quotation, express this idea. Of course, Wordsworth is a poet writing a poem, and is not concerned with dry philosophical statements. But it would hardly be possible to express more clearly a feeling for nature, as exhibiting entwined prehensive unities, each suffused with modal presences of others:

> 'Ye Presences of Nature in the sky
> And on the earth!' Ye Visions of the hills!
> And Souls of lonely places! can I think
> A vulgar hope was yours when ye employed
> Such ministry, when ye through many a year
> Haunting me thus among my boyish sports,
> On caves and trees, upon the woods and hills,
> Impressed upon all forms the characters
> Of danger or desire; and thus did make
> The surface of the universal earth,
> With triumph and delight, with hope and fear,
> Work like a sea? . . .'

In thus citing Wordsworth, the point which I wish to make is that we forget how strained and paradoxical is the view of nature which modern science imposes on our thoughts. Wordsworth, to the height of genius, expresses the concrete facts of our apprehension, facts which are distorted in the scientific analysis. Is it not possible that the standardised concepts of science are only valid within narrow limitations, perhaps too narrow for science itself?

Shelley's attitude to science was at the opposite pole to that of Wordsworth. He loved it, and is never tired of expressing in poetry the thoughts which it suggests. It symbolises to him joy, and peace, and illumination. What the hills were to the youth of Wordsworth, a chemical laboratory was to Shelley. It is unfortunate that Shelley's literary critics have, in this respect, so little of Shelley in their own mentality. They tend to treat as a casual oddity of Shelley's nature what was, in fact, part of the main structure of his mind, permeating

his poetry through and through. If Shelley had been born a hundred years later, the twentieth century would have seen a Newton among chemists.

For the sake of estimating the value of Shelley's evidence it is important to realise this absorption of his mind in scientific ideas. It can be illustrated by lyric after lyric. I will choose one poem only, the fourth act of his *Prometheus Unbound*. The Earth and the Moon converse together in the language of accurate science. Physical experiments guide his imagery. For example, the Earth's exclamation,

'The vaporous exultation not to be confined!'

is the poetic transcript of 'the expansive force of gases,' as it is termed in books on science. Again, take the Earth's stanza,

'I spin beneath my pyramid of night,
Which points into the heavens,—dreaming delight,
Murmuring victorious joy in my enchanted sleep;
As a youth lulled in love-dreams faintly sighing,
Under the shadow of his beauty lying,
Which round his rest a watch of light and warmth doth keep.'

This stanza could only have been written by someone with a definite geometrical diagram before his inward eye—a diagram which it has often been my business to demonstrate to mathematical classes. As evidence, note especially the last line which gives poetical imagery to the light surrounding night's pyramid. This idea could not occur to anyone without the diagram. But the whole poem and other poems are permeated with touches of this kind.

Now the poet, so sympathetic with science, so absorbed in its ideas, can simply make nothing of the doctrine of secondary qualities which is fundamental to its concepts. For Shelley nature retains its beauty and its colour. Shelley's nature is in its essence a nature of organisms, functioning with the full content of our perceptual experience. We are so used to ignoring the implication of orthodox scientific doctrine, that it is difficult to make evident the criticism upon it which is thereby implied. If anybody could have treated it seriously, Shelley would have done so.

Furthermore Shelley is entirely at one with Wordsworth as to the interfusing of the Presence in nature. Here is the opening stanza of his poem entitled *Mont Blanc:*

'The everlasting universe of Things
Flows through the Mind, and rolls its rapid waves,
Now dark—now glittering—now reflecting gloom—
Now lending splendour, where from secret springs
The source of human thought its tribute brings
Of waters,—with a sound but half its own,
Such as a feeble brook will oft assume
In the wild woods, among the Mountains lone,
Where waterfalls around it leap for ever,
Where woods and winds contend, and a vast river
Over its rocks ceaselessly bursts and raves.'

Shelley has written these lines with explicit reference to some form of idealism, Kantian or Berkeleyan or Platonic. But however you construe him, he is here an emphatic witness to a prehensive unification as constituting the very being of nature.

Berkeley, Wordsworth, Shelley are representative of the intuitive refusal seriously to accept the abstract materialism of science.

There is an interesting difference in the treatment of nature by Wordsworth and by Shelley, which brings forward the exact questions we have got to think about. Shelley thinks of nature as changing, dissolving, transforming as it were at a fairy's touch. The leaves fly before the West Wind

'Like ghosts from an enchanter fleeing.'

In his poem *The Cloud* it is the transformations of water which excite his imagination. The subject of the poem is the endless, eternal, elusive change of things:

'I change but I cannot die.'

This is one aspect of nature, its elusive change: a change not merely to be expressed by locomotion, but a change of inward character. This is where Shelley places his emphasis, on the change of what cannot die.

Wordsworth was born among hills; hills mostly barren of trees, and thus showing the minimum of change with the seasons. He was haunted by the enormous permanences of nature. For him change is an incident which shoots across a background of endurance,

'Breaking the silence of the seas
Among the farthest Hebrides.'

Every scheme for the analysis of nature has to face these two facts, *change* and *endurance*. There is yet a third fact to be placed by it, *eternality*, I will call it. The mountain endures. But when after ages it has been worn away, it has gone. If a replica arises, it is yet a new mountain. A colour is eternal. It haunts time like a spirit. It comes and it goes. But where it comes, it is the same colour. It neither survives nor does it live. It appears when it is wanted. The mountain has to time and space a different relation from that which colour has. In the previous lecture, I was chiefly considering the relation to space-time of things which, in my sense of the term, are eternal. It was necessary to do so before we can pass to the consideration of the things which endure.

Also we must recollect the basis of our procedure. I hold that philosophy is the critic of abstractions. Its function is the double one, first of harmonising them by assigning to them their right relative status as abstractions, and secondly of completing them by direct comparison with more concrete intuitions of the universe, and thereby promoting the formation of more complete schemes of thought. It is in respect to this comparison that the testimony of great poets is of such importance. Their survival is evidence that they express deep intuitions of mankind of penetrating into what is universal in concrete fact. Philosophy is not one among the sciences with its own little scheme of abstractions which it works away at perfecting and improving. It is the survey of sciences, with the special objects of their harmony, and of their completion. It brings to this task, not only the evidence of the separate sciences, but also its own appeal to concrete experience. It confronts the sciences with concrete fact.

The literature of the nineteenth century, especially its English poetic literature, is a witness to the discord between the aesthetic intuitions of mankind and the mechanism of science. Shelley brings vividly before us the elusiveness of the eternal objects of sense as they haunt the change which infects underlying organisms. Wordsworth is the poet of nature as being the field of enduring permanences carrying within themselves a message of tremendous significance. The eternal objects are also there for him,

'The light that never was, on sea or land.'

Both Shelley and Wordsworth emphatically bear witness that nature cannot be divorced from its aesthetic values; and that these values

arise from the cumulation, in some sense, of the brooding presence of the whole on to its various parts. Thus we gain from the poets the doctrine that a philosophy of nature must concern itself at least with these six notions: change, value, eternal objects, endurance, organism, interfusion.

We see that the literary romantic movement at the beginning of the nineteenth century, just as much as Berkeley's philosophical idealistic movement a hundred years earlier, refused to be confined within the materialistic concepts of the orthodox scientific theory. We know also that when in these lectures we come to the twentieth century, we shall find a movement in science itself to reorganise its concepts, driven thereto by its own intrinsic development.

It is, however, impossible to proceed until we have settled whether this refashioning of ideas is to be carried out on an objectivist basis or on a subjectivist basis. By a subjectivist basis I mean the belief that the nature of our immediate experience is the outcome of the perceptive peculiarities of the subject enjoying the experience. In other words, I mean that for this theory what is perceived is not a partial vision of a complex of things generally independent of that act of cognition; but that it merely is the expression of the individual peculiarities of the cognitive act. Accordingly what is common to the multiplicity of cognitive acts is the ratiocination connected with them. Thus, though there is a common world of thought associated with our sense-perceptions, there is no common world to think about. What we do think about is a common conceptual world applying indifferently to our individual experiences which are strictly personal to ourselves. Such a conceptual world will ultimately find its complete expression in the equations of applied mathematics. This is the extreme subjectivist position. There is of course the half-way house of those who believe that our perceptual experience does tell us of a common objective world; but that the things perceived are merely the outcome for us of this world, and are not *in themselves* elements in the common world itself.

Also there is the objectivist position. This creed is that the actual elements perceived by our senses are *in themselves* the elements of a common world; and that this world is a complex of things, including indeed our acts of cognition, but transcending them. According to this point of view the things experienced are to be distinguished from our knowledge of them. So far as there is dependence, the *things* pave the way for the *cognition,* rather than *vice versa.* But the point is

that the actual things experienced enter into a common world which transcends knowledge, though it includes knowledge. The intermediate subjectivists would hold that the things experienced only indirectly enter into the common world by reason of their dependence on the subject who is cognising. The objectivist holds that the things experienced and the cognisant subject enter into the common world on equal terms. In these lectures I am giving the outline of what I consider to be the essentials of an objectivist philosophy adapted to the requirement of science and to the concrete experience of mankind. Apart from the detailed criticism of the difficulties raised by subjectivism in any form, my broad reasons for distrusting it are three in number. One reason arises from the direct interrogation of our perceptive experience. It appears from this interrogation that we are *within* a world of colours, sounds, and other sense-objects, related in space and time to enduring objects such as stones, trees, and human bodies. We seem to be ourselves elements of this world in the same sense as are the other things which we perceive. But the subjectivist, even the moderate intermediate subjectivist, makes this world, as thus described, depend on us, in a way which directly traverses our naïve experience. I hold that the ultimate appeal is to naïve experience and that is why I lay such stress on the evidence of poetry. My point is, that in our sense-experience we know away from and beyond our own personality; whereas the subjectivist holds that in such experience we merely know about our own personality. Even the intermediate subjectivist places our personality between the world we know of and the common world which he admits. The world we know of is for him the internal strain of our personality under the stress of the common world which lies behind.

My second reason for distrusting subjectivism is based on the particular content of experience. Our historical knowledge tells us of ages in the past when, so far as we can see, no living being existed on earth. Again it also tells us of countless star-systems, whose detailed history remains beyond our ken. Consider even the moon and the earth. What is going on within the interior of the earth, and on the far side of the moon! Our perceptions lead us to infer that there is something happening in the stars, something happening within the earth, and something happening on the far side of the moon. Also they tell us that in remote ages there were things happening. But all these things which it appears certainly happened, are either unknown

in detail, or else are reconstructed by inferential evidence. In the face of this content of our personal experience, it is difficult to believe that the experienced world is an attribute of our own personality. My third reason is based upon the instinct for action. Just as sense-perception seems to give knowledge of what lies beyond individuality, so action seems to issue in an instinct for self-transcendence. The activity passes beyond self into the known transcendent world. It is here that final ends are of importance. For it is not activity urged from behind, which passes out into the veiled world of the intermediate subjectivist. It is activity directed to determinate ends in the known world; and yet it is activity transcending self and it is activity within the known world. It follows therefore that the world, as known, transcends the subject which is cognisant of it.

The subjectivist position has been popular among those who have been engaged in giving a philosophical interpretation to the recent theories of relativity in physical science. The dependence of the world of sense on the individual percipient seems an easy mode of expressing the meanings involved. Of course, with the exception of those who are content with themselves as forming the entire universe, solitary amid nothing, everyone wants to struggle back to some sort of objectivist position. I do not understand how a common world of thought can be established in the absence of a common world of sense. I will not argue this point in detail; but in the absence of a transcendence of thought, or a transcendence of the world of sense, it is difficult to see how the subjectivist is to divest himself of his solitariness. Nor does the intermediate subjectivist appear to get any help from his unknown world in the background.

The distinction between realism and idealism does not coincide with that between objectivism and subjectivism. Both realists and idealists can start from an objective standpoint. They may both agree that the world disclosed in sense-perception is a common world, transcending the individual recipient. But the objective idealist, when he comes to analyse what the reality of this world involves, finds that cognitive mentality is in some way inextricably concerned in every detail. This position the realist denies. Accordingly these two classes of objectivists do not part company till they have arrived at the ultimate problem of metaphysics. There is a great deal which they share in common. This is why, in my last lecture, I said that I adopted a position of provisional realism.

In the past, the objectivist position has been distorted by the supposed necessity of accepting the classical scientific materialism, with its doctrine of simple location. This has necessitated the doctrine of secondary and primary qualities. Thus the secondary qualities, such as the sense-objects, are dealt with on subjectivist principles. This is a half-hearted position which falls an easy prey to subjectivist criticism.

If we are to include the secondary qualities in the common world, a very drastic reorganisation of our fundamental concept is necessary. It is an evident fact of experience that our apprehensions of the external world depend absolutely on the occurrences within the human body. By playing appropriate tricks on the body a man can be got to perceive, or not to perceive, almost anything. Some people express themselves as though bodies, brains, and nerves were the only real things in an entirely imaginary world. In other words, they treat bodies on objectivist principles, and the rest of the world on subjectivist principles. This will not do; especially, when we remember that it is the experimenter's perception of another person's body which is in question as evidence.

But we have to admit that the body is the organism whose states regulate our cognisance of the world. The unity of the perceptual field therefore must be a unity of bodily experience. In being aware of the bodily experience, we must thereby be aware of aspects of the whole spatio-temporal world as mirrored within the bodily life. This is the solution of the problem which I gave in my last lecture. I will not repeat myself now, except to remind you that my theory involves the entire abandonment of the notion that simple location is the primary way in which things are involved in space-time. In a certain sense, everything is everywhere at all times. For every location involves an aspect of itself in every other location. Thus every spatio-temporal standpoint mirrors the world.

If you try to imagine this doctrine in terms of our conventional views of space and time, which presuppose simple location, it is a great paradox. But if you think of it in terms of our naïve experience, it is a mere transcript of the obvious facts. You are in a certain place perceiving things. Your perception takes place where you are, and is entirely dependent on how your body is functioning. But this functioning of the body in one place, exhibits for your cognisance an aspect of the distant environment, fading away into the general

knowledge that there are things beyond. If this cognisance conveys knowledge of a transcendent world, it must be because the event which is the bodily life unifies in itself aspects of the universe.

This is a doctrine extremely consonant with the vivid expression of personal experience which we find in the nature-poetry of imaginative writers such as Wordsworth or Shelley. The brooding, immediate presences of things are an obsession to Wordsworth. What the theory does do is to edge cognitive mentality away from being the necessary substratum of the unity of experience. That unity is now placed in the unity of an event. Accompanying this unity, there may or there may not be cognition.

At this point we come back to the great question which was posed before us by our examination of the evidence afforded by the poetic insight of Wordsworth and Shelley. This single question has expanded into a group of questions. What are enduring things, as distinguished from the eternal objects, such as colour and shape? How are they possible? What is their status and meaning in the universe? It comes to this: What is the status of the enduring stability of the order of nature? There is the summary answer, which refers nature to some greater reality standing behind it. This reality occurs in the history of thought under many names, The Absolute, Brahma, The Order of Heaven, God. The delineation of final metaphysical truth is no part of this lecture. My point is that any summary conclusion jumping from our conviction of the existence of such an order of nature to the easy assumption that there is an ultimate reality which, in some unexplained way, is to be appealed to for the removal of perplexity, constitutes the great refusal of rationality to assert its rights. We have to search whether nature does not in its very being show itself as self-explanatory. By this I mean, that the sheer statement, of what things are, may contain elements explanatory of why things are. Such elements may be expected to refer to depths beyond anything which we can grasp with a clear apprehension. In a sense, all explanation must end in an ultimate arbitrariness. My demand is, that the ultimate arbitrariness of matter of fact from which our formulation starts should disclose the same general principles of reality, which we dimly discern as stretching away into regions beyond our explicit powers of discernment. Nature exhibits itself as exemplifying a philosophy of the evolution of organisms subject to determinate conditions. Examples of such conditions are the dimen-

sions of space, the laws of nature, the determinate enduring entities, such as atoms and electrons, which exemplify these laws. But the very nature of these entities, the very nature of their spatiality and temporality, should exhibit the arbitrariness of these conditions as the outcome of a wider evolution beyond nature itself, and within which nature is but a limited mode.

One all-pervasive fact, inherent in the very character of what is real is the transition of things, the passage one to another. This passage is not a mere linear procession of discrete entities. However we fix a determinate entity, there is always a narrow determination of something which is presupposed in our first choice. Also there is always a wider determination into which our first choice fades by transition beyond itself. The general aspect of nature is that of evolutionary expansiveness. These unities, which I call events, are the emergence into actuality of something. How are we to characterise the something which thus emerges? The name *'event'* given to such a unity, draws attention to the inherent transitoriness, combined with the actual unity. But this abstract word cannot be sufficient to characterise what the fact of the reality of an event is in itself. A moment's thought shows us that no one idea can in itself be sufficient. For every idea which finds its significance in each event must represent something which contributes to what realisation is in itself. Thus no one word can be adequate. But conversely, nothing must be left out. Remembering the poetic rendering of our concrete experience, we see at once that the element of value, of being valuable, of having value, of being an end in itself, of being something which is for its own sake, must not be omitted in any account of an event as the most concrete actual something. 'Value' is the word I use for the intrinsic reality of an event. Value is an element which permeates through and through the poetic view of nature. We have only to transfer to the very texture of realisation in itself that value which we recognise so readily in terms of human life. This is the secret of Wordsworth's worship of nature. Realisation therefore is in itself the attainment of value. But there is no such thing as mere value. Value is the outcome of limitation. The definite finite entity is the selected mode which is the shaping of attainment; apart from such shaping into individual matter of fact there is no attainment. The mere fusion of all that there is would be the nonentity of indefiniteness. The salvation of reality is its obstinate, irreducible, matter-of-fact entities,

which are limited to be no other than themselves. Neither science, nor art, nor creative action can tear itself away from obstinate, irreducible, limited facts. The endurance of things has its significance in the self-retention of that which imposes itself as a definite attainment for its own sake. That which endures is limited, obstructive, intolerant, infecting its environment with its own aspects. But it is not self-sufficient. The aspects of all things enter into its very nature. It is only itself as drawing together into its own limitation the larger whole in which it finds itself. Conversely it is only itself by lending its aspects to this same environment in which it finds itself. The problem of evolution is the development of enduring harmonies of enduring shapes of value, which merge into higher attainments of things beyond themselves. Aesthetic attainment is interwoven in the texture of realisation. The endurance of an entity represents the attainment of a limited aesthetic success, though if we look beyond it to its external effects, it may represent an aesthetic failure. Even within itself, it may represent the conflict between a lower success and a higher failure. The conflict is the presage of disruption.

The further discussion of the nature of enduring objects and of the conditions they require will be relevant to the consideration of the doctrine of evolution which dominated the latter half of the nineteenth century. The point which in this lecture I have endeavoured to make clear is that the nature-poetry of the romantic revival was a protest on behalf of the organic view of nature, and also a protest against the exclusion of value from the essence of matter of fact. In this aspect of it, the romantic movement may be conceived as a revival of Berkeley's protest which had been launched a hundred years earlier. The romantic reaction was a protest on behalf of value.

CHAPTER VI *THE NINETEENTH CENTURY*

My previous lecture was occupied with the comparison of the nature-poetry of the romantic movement in England with the materialistic scientific philosophy inherited from the eighteenth century. It noted the entire disagreement of the two movements of thought. The lecture also continued the endeavour to outline an objectivist

philosophy, capable of bridging the gap between science and that fundamental intuition of mankind which finds its expression in poetry and its practical exemplification in the presuppositions of daily life. As the nineteenth century passed on, the romantic movement died down. It did not die away, but it lost its clear unity of tidal stream, and dispersed itself into many estuaries as it coalesced with other human interests. The faith of the century was derived from three sources: one source was the romantic movement, showing itself in religious revival, in art, and in political aspiration: another source was the gathering advance of science which opened avenues of thought: the third source was the advance in technology which completely changed the conditions of human life.

Each of these springs of faith had its origin in the previous period. The French Revolution itself was the first child of romanticism in the form in which it tinged Rousseau. James Watt obtained his patent for his steam-engine in 1769. The scientific advance was the glory of France and of French influence, throughout the same century.

Also even during this earlier period, the streams interacted, coalesced, and antagonised each other. But it was not until the nineteenth century that the three-fold movement came to that full development and peculiar balance characteristic of the sixty years following the battle of Waterloo.

What is peculiar and new to the century, differentiating it from all its predecessors, is its technology. It was not merely the introduction of some great isolated inventions. It is impossible not to feel that something more than that was involved. For example, writing was a greater invention than the steam-engine. But in tracing the continuous history of the growth of writing we find an immense difference from that of the steam-engine. We must, of course, put aside minor and sporadic anticipations of both; and confine attention to the periods of their effective elaboration. For scale of time is so absolutely disparate. For the steam-engine, we may give about a hundred years; for writing, the time period is of the order of a thousand years. Further, when writing was finally popularised, the world was not then expecting the next step in technology. The process of change was slow, unconscious, and unexpected.

In the nineteenth century, the process became quick, conscious, and expected. The earlier half of the century was the period in which this new attitude to change was first established and enjoyed. It was

a peculiar period of hope, in the sense in which, sixty or seventy years later, we can now detect a note of disillusionment, or at least of anxiety.

The greatest invention of the nineteenth century was the invention of the method of invention. A new method entered into life. In order to understand our epoch, we can neglect all the details of change, such as railways, telegraphs, radios, spinning machines, synthetic dyes. We must concentrate on the method in itself; that is the real novelty, which has broken up the foundations of the old civilisation. The prophecy of Francis Bacon has now been fulfilled; and man, who at times dreamt of himself as a little lower than the angels, has submitted to become the servant and the minister of nature. It still remains to be seen whether the same actor can play both parts.

The whole change has arisen from the new scientific information. Science, conceived not so much in its principles as in its results, is an obvious storehouse of ideas for utilisation. But, if we are to understand what happened during the century, the analogy of a mine is better than that of a storehouse. Also, it is a great mistake to think that the bare scientific idea is the required invention, so that it has only to be picked up and used. An intense period of imaginative design lies between. One element in the new method is just the discovery of how to set about bridging the gap between the scientific ideas, and the ultimate product. It is a process of disciplined attack upon one difficulty after another.

The possibilities of modern technology were first in practice realised in England, by the energy of a prosperous middle class. Accordingly, the industrial revolution started there. But the Germans explicitly realised the methods by which the deeper veins in the mine of science could be reached. They abolished haphazard methods of scholarship. In their technological schools and universities progress did not have to wait for the occasional genius, or the occasional lucky thought. Their feats of scholarship during the nineteenth century were the admiration of the world. This discipline of knowledge applies beyond technology to pure science, and beyond science to general scholarship. It represents the change from amateurs to professionals.

There have always been people who devoted their lives to definite regions of thought. In particular, lawyers and the clergy of the Christian churches form obvious examples of such specialism. But the full

self-conscious realisation of the power of professionalism in knowledge in all its departments, and of the way to produce the professionals, and of the importance of knowledge to the advance of technology, and of the methods by which abstract knowledge can be connected with technology, and of the boundless possibilities of technological advance,—the realisation of all these things was first completely attained in the nineteenth century; and among the various countries, chiefly in Germany.

In the past human life was lived in a bullock cart; in the future it will be lived in an aeroplane; and the change of speed amounts to a difference in quality.

The transformation of the field of knowledge, which has been thus effected, has not been wholly a gain. At least, there are dangers implicit in it, although the increase of efficiency is undeniable. The discussion of various effects on social life arising from the new situation is reserved for my last lecture. For the present it is sufficient to note that this novel situation of disciplined progress is the setting within which the thought of the century developed.

In the period considered four great novel ideas were introduced into theoretical science. Of course, it is possible to show good cause for increasing my list far beyond the number *four*. But I am keeping to ideas which, if taken in their broadest signification, are vital to modern attempts at reconstructing the foundations of physical science.

Two of these ideas are antithetical, and I will consider them together. We are not concerned with details, but with ultimate influences on thought. One of the ideas is that of a field of physical activity pervading all space, even where there is an apparent vacuum. This notion had occurred to many people, under many forms. We remember the medieval axiom, nature abhors a vacuum. Also, Descartes' vortices at one time, in the seventeenth century, seemed as if established among scientific assumptions. Newton believed that gravitation was caused by something happening in a medium. But, on the whole, in the eighteenth century nothing was made of any of these ideas. The passage of light was explained in Newton's fashion by the flight of minute corpuscles, which of course left room for a vacuum. Mathematical physicists were far too busy deducing the consequences of the theory of gravitation to bother much about the causes; nor did they know where to look, if they had troubled themselves over the question. There were speculations, but their importance was not

great. Accordingly, when the nineteenth century opened, the notion of physical occurrences pervading all space held no effective place in science. It was revived from two sources. The undulatory theory of light triumphed, thanks to Thomas Young and Fresnel. This demands that there shall be something throughout space which can undulate. Accordingly, the ether was produced, as a sort of all-pervading subtle material. Again the theory of electromagnetism finally, in Clerk Maxwell's hands, assumed a shape in which it demanded that there should be electromagnetic occurrences throughout all space. Maxwell's complete theory was not shaped until the eighteen-seventies. But it had been prepared for by many great men, Ampère, Oersted, Faraday. In accordance with the current materialistic outlook, these electromagnetic occurrences also required a material in which to happen. So again the ether was requisitioned. Then Maxwell, as the immediate first-fruits of his theory, demonstrated that the waves of light were merely waves of his electromagnetic occurrences. Accordingly, the theory of electromagnetism swallowed up the theory of light. It was a great simplification, and no one doubts its truth. But it had one unfortunate effect so far as materialism was concerned. For, whereas quite a simple sort of elastic ether sufficed for light when taken by itself, the electromagnetic ether has to be endowed with just those properties necessary for the production of the electromagnetic occurrences. In fact, it becomes a mere name for the material which is postulated to underlie these occurrences. If you do not happen to hold the metaphysical theory which makes you postulate such an ether, you can discard it. For it has no independent vitality.

Thus in the seventies of the last century, some main physical sciences were established on a basis which presupposed the idea of *continuity*. On the other hand, the idea of *atomicity* had been introduced by John Dalton, to complete Lavoisier's work on the foundation of chemistry. This is the second great notion. Ordinary matter was conceived as atomic: electromagnetic effects were conceived as arising from a continuous field.

There was no contradiction. In the first place, the notions are antithetical; but, apart from special embodiments, are not logically contradictory. Secondly, they were applied to different regions of science, one to chemistry, and the other to electromagnetism. And, as yet, there were but faint signs of coalescence between the two.

The notion of matter as atomic has a long history. Democritus and Lucretius will at once occur to your minds. In speaking of these ideas as novel, I merely mean *relatively novel,* having regard to the settlement of ideas which formed the efficient basis of science throughout the eighteenth century. In considering the history of thought, it is necessary to distinguish the real stream, determining a period, from ineffectual thoughts casually entertained. In the eighteenth century every well-educated man read Lucretius, and entertained ideas about atoms. But John Dalton made them efficient in the stream of science; and in this function of efficiency atomicity was a new idea.

The influence of atomicity was not limited to chemistry. The living cell is to biology what the electron and the proton are to physics. Apart from cells and from aggregates of cells there are no biological phenomena. The cell theory was introduced into biology contemporaneously with, and independently of, Dalton's atomic theory. The two theories are independent exemplifications of the same idea of 'atomism.' The biological cell theory was a gradual growth, and a mere list of dates and names illustrates the fact that the biological sciences, as effective schemes of thought, are barely one hundred years old. Bichât in 1801 elaborated a tissue theory: Johannes Müller in 1835 described 'cells' and demonstrated facts concerning their nature and relations: Schleiden in 1838 and Schwann in 1839 finally established their fundamental character. Thus by 1840 both biology and chemistry were established on an atomic basis. The final triumph of atomism had to wait for the arrival of electrons at the end of the century. The importance of the imaginative background is illustrated by the fact that nearly half a century after Dalton had done his work, another chemist, Louis Pasteur, carried over these same ideas of atomicity still further into the region of biology. The cell theory and Pasteur's work were in some respects more revolutionary than that of Dalton. For they introduced the notion of *organism* into the world of minute beings. There had been a tendency to treat the atom as an ultimate entity, capable only of external relations. This attitude of mind was breaking down under the influence of Mendeleef's periodic law. But Pasteur showed the decisive importance of the idea of organism at the stage of infinitesimal magnitude. The astronomers had shown us how big is the universe. The chemists and biologists teach us how small it is. There is in modern scientific practice a famous standard of length. It is rather small:

to obtain it, you must divide a centimetre into one hundred million parts, and take one of them. Pasteur's organisms are a good deal bigger than this length. In connection with atoms, we now know that there are organisms for which such distances are uncomfortably great.

The remaining pair of new ideas to be ascribed to this epoch are both of them connected with notion of transition or change. They are the doctrine of the conservation of energy, and the doctrine of evolution.

The doctrine of energy has to do with the notion of quantitative permanence underlying change. The doctrine of evolution has to do with the emergence of novel organisms as the outcome of chance. The theory of energy lies in the province of physics. The theory of evolution lies mainly in the province of biology, although it had previously been touched upon by Kant and Laplace in connection with the formation of suns and planets.

The convergent effect of the new power for scientific advance, which resulted from these four ideas, transformed the middle period of the century into an orgy of scientific triumph. Clear-sighted men, of the sort who are so clearly wrong, now proclaimed that the secrets of the physical universe were finally disclosed. If only you ignored everything which refused to come into line, your powers of explanation were unlimited. On the other side, muddle-headed men muddled themselves into the most indefensible positions. Learned dogmatism, conjoined with ignorance of the crucial facts, suffered a heavy defeat from the scientific advocates of new ways. Thus to the excitement derived from technological revolution, there was now added the excitement arising from the vistas disclosed by scientific theory. Both the material and the spiritual bases of social life were in process of transformation. When the century entered upon its last quarter, its three sources of inspiration, the romantic, the technological, and the scientific had done their work.

Then, almost suddenly, a pause occurred; and in its last twenty years the century closed with one of the dullest stages of thought since the time of the First Crusade. It was an echo of the eighteenth century, lacking Voltaire and the reckless grace of the French aristocrats. The period was efficient, dull, and half-hearted. It celebrated the triumph of the professional man.

But looking backwards upon this time of pause, we can now

discern signs of change. In the first place, the modern conditions of systematic research prevent absolute stagnation. In every branch of science, there was effective progress, indeed rapid progress, although it was confined somewhat strictly within the accepted ideas of each branch. It was an age of successful scientific orthodoxy, undisturbed by much thought beyond the conventions.

In the second place, we can now see that the adequacy of scientific materialism as a scheme of thought for the use of science was endangered. The conservation of energy provided a new type of quantitative permanence. It is true that energy could be construed as something subsidiary to matter. But, anyhow, the notion of *mass* was losing its unique preëminence as being the one final permanent quantity. Later on, we find the relations of mass and energy inverted; so that mass now becomes the name for a quantity of energy considered in relation to some of its dynamical effects. This train of thought leads to the notion of energy being fundamental, thus displacing matter from that position. But energy is merely the name for the quantitative aspect of a structure of happenings; in short, it depends on the notion of the functioning of an organism. The question is, can we define an organism without recurrence to the concept of matter in simple location? We must, later on, consider this point in more detail.

The same relegation of matter to the background occurs in connection with the electromagnetic fields. The modern theory presupposes happenings in that field which are divorced from immediate dependence upon matter. It is usual to provide an ether as a substratum. But the ether does not really enter into the theory. Thus again the notion of material loses its fundamental position. Also, the atom is transforming itself into an organism; and finally the evolution theory is nothing else than the analysis of the conditions for the formation and survival of various types of organisms. In truth, one most significant fact of this later period is the advance in biological sciences. These sciences are essentially sciences concerning organisms. During the epoch in question, and indeed also at the present moment, the prestige of the more perfect scientific form belongs to the physical sciences. Accordingly, biology apes the manners of physics. It is orthodox to hold, that there is nothing in biology but what is physical mechanism under somewhat complex circumstances.

One difficulty in this position is the present confusion as to the foundational concepts of physical science. This same difficulty also attaches to the opposed doctrine of vitalism. For, in this later theory, the fact of mechanism is accepted—I mean, mechanism based upon materialism—and an additional vital control is introduced to explain the actions of living bodies. It cannot be too clearly understood that the various physical laws which appear to apply to the behaviour of atoms are not mutually consistent as at present formulated. The appeal to mechanism on behalf of biology was in its origin an appeal to the well-attested self-consistent physical concepts as expressing the basis of all natural phenomena. But at present there is no such system of concepts.

Science is taking on a new aspect which is neither purely physical, nor purely biological. It is becoming the study of organisms. Biology is the study of the larger organisms; whereas physics is the study of the smaller organisms. There is another difference between the two divisions of science. The organisms of biology include as ingredients the smaller organisms of physics; but there is at present no evidence that the smaller of the physical organisms can be analysed into component organisms. It may be so. But anyhow we are faced with the question as to whether there are not primary organisms which are incapable of further analysis. It seems very unlikely that there should be any infinite regress in nature. Accordingly, a theory of science which discards materialism must answer the question as to the character of these primary entities. There can be only one answer on this basis. We must start with the event as the ultimate unit of natural occurrence. An event has to do with all that there is, and in particular with all other events. This interfusion of events is effected by the aspects of those eternal objects, such as colours, sounds, scents, geometrical characters, which are required for nature and are not emergent from it. Such an eternal object will be an ingredient of one event under the guise, or aspect, of qualifying another event. There is a reciprocity of aspects, and there are patterns of aspects. Each event corresponds to two such patterns; namely, the pattern of aspects of other events which it grasps into its own unity, and the pattern of its aspects which other events severally grasp into their unities. Accordingly, a non-materialistic philosophy of nature will identify a primary organism as being the emergence of some particular pattern as grasped in the unity of a real event.

Such a pattern will also include the aspects of the event in question as grasped in other events, whereby those other events receive a modification, or partial determination. There is thus an intrinsic and an extrinsic reality of an event, namely, the event as in its own prehension, and the event as in the prehension of other events. The concept of an organism includes, therefore, the concept of the interaction of organisms. The ordinary scientific ideas of transmission and continuity are, relatively speaking, details concerning the empirically observed characters of these patterns throughout space and time. The position here maintained is that the relationships of an event are internal, so far as concerns the event itself; that is to say, that they are constitutive of what the event is in itself.

Also in the previous lecture, we arrived at the notion that an actual event is an achievement for its own sake, a grasping of diverse entities into a value by reason of their real togetherness in that pattern, to the exclusion of other entities. It is not the mere logical togetherness of merely diverse things. For in that case, to modify Bacon's words, 'all eternal objects would be alike one to another.' This reality means that each intrinsic essence, that is to say, what each eternal object is in itself, becomes relevant to the one limited value emergent in the guise of the event. But values differ in importance. Thus though each event is necessary for the community of events, the weight of its contribution is determined by something intrinsic in itself. We have now to discuss what that property is. Empirical observation shows that it is the property which we may call indifferently *retention, endurance* or *reiteration*. This property amounts to the recovery, on behalf of value amid the transitoriness of reality, of the self-identity which is also enjoyed by the primary eternal objects. The reiteration of a particular shape (or formation) of value within an event occurs when the event as a whole repeats some shape which is also exhibited by each one of a succession of its parts. Thus however you analyse the event according to the flux of its parts through time, there is the same thing-for-its-own-sake standing before you. Thus the event, in its own intrinsic reality, mirrors in itself, as derived from its own parts, aspects of the same patterned value as it realises in its complete self. It thus realises itself under the guise of an enduring individual entity, with a life history contained within itself. Furthermore, the extrinsic reality of such an event, as mirrored in other events, takes this same form

of an enduring individuality; only in this case, the individuality is implanted as a reiteration of aspects of itself in the alien events composing the environment.

The total temporal duration of such an event bearing an enduring pattern, constitutes its specious present. Within this specious present the event realises itself as a totality, and also in so doing realises itself as grouping together a number of aspects of its own temporal parts. One and the same pattern is realised in the total event, and is exhibited by each of these various parts through an aspect of each part grasped into the togetherness of the total event. Also, the earlier life-history of the same pattern is exhibited by its aspects in this total event. There is, thus, in this event a memory of the antecedent life-history of its own dominant pattern, as having formed an element of value in its own antecedent environment. This concrete prehension, from within, of the life-history of an enduring fact is analysable into two abstractions, of which one is the enduring entity which has emerged as a real matter of fact to be taken account of by other things, and the other is the individualised embodiment of the underlying energy of realisation.

The consideration of the general flux of events leads to this analysis into an underlying eternal energy in whose nature there stands an envisagement of the realm of all eternal objects. Such an envisagement is the ground of the individualised thoughts which emerge as thought-aspects grasped within the life-history of the subtler and more complex enduring patterns. Also in the nature of the eternal activity there must stand an envisagement of all values to be obtained by a real togetherness of eternal objects, as envisaged in ideal situations. Such ideal situations, apart from any reality, are devoid of intrinsic value, but are valuable as elements in purpose. The individualised prehension into individual events of aspects of these ideal situations takes the form of individualised thoughts, and as such has intrinsic value. Thus value arises because there is now a real togetherness of the ideal aspects, as in thought, with the actual aspects, as in process of occurrence. Accordingly no value is to be ascribed to the underlying activity as divorced from the matter-of-fact events of the real world.

Finally, to sum up this train of thought, the underlying activity, as conceived apart from the fact of realisation, has three types of envisagement. These are: first, the envisagement of eternal objects;

secondly, the envisagement of possibilities of value in respect to the synthesis of eternal objects; and lastly, the envisagement of the actual matter of fact which must enter into the total situation which is achievable by the addition of the future. But in abstraction from actuality, the eternal activity is divorced from value. For the actuality is the value. The individual perception arising from enduring objects will vary in its individual depth and width according to the way in which the pattern dominates its own route. It may represent the faintest ripple differentiating the general substrate energy; or, in the other extreme, it may rise to conscious thought, which includes poising before self-conscious judgment the abstract possibilities of value inherent in various situations of ideal togetherness. The intermediate cases will group round the individual perception as envisaging (without self-consciousness) that one immediate possibility of attainment which represents the closest analogy to its own immediate past, having regard to the actual aspects which are there for prehension. The laws of physics represent the harmonised adjustment of development which results from this unique principle of determination. Thus dynamics is dominated by a principle of least action, whose detailed character has to be learnt from observation.

The atomic material entities which are considered in physical science are merely these individual enduring entities, conceived in abstraction from everything except what concerns their mutual interplay in determining each other's historical routes of life-history. Such entities are partially formed by the inheritance of aspects from their own past. But they are also partially formed by the aspects of other events forming their environments. The laws of physics are the laws declaring how the entities mutually react among themselves. For physics these laws are arbitrary, because that science has abstracted from what the entities are in themselves. We have seen that this fact of what the entities are in themselves is liable to modification by their environments. Accordingly, the assumption that no modification of these laws is to be looked for in environments, which have any striking difference from the environments for which the laws have been observed to hold, is very unsafe. The physical entities may be modified in very essential ways, so far as these laws are concerned. It is even possible that they may be developed into individualities of more fundamental types, with wider embodiment of envisagement. Such envisagement might reach to the attainment

of the poising of alternative values with exercise of choice lying outside the physical laws, and expressible only in terms of purpose. Apart from such remote possibilities, it remains an immediate deduction that an individual entity, whose own life-history is a part within the life-history of some larger, deeper, more complete pattern, is liable to have aspects of that larger pattern dominating its own being, and to experience modifications of that larger pattern reflected in itself as modifications of its own being. This is the theory of organic mechanism.

According to this theory the evolution of laws of nature is concurrent with the evolution of enduring pattern. For the general state of the universe, as it now is, partly determines the very essences of the entities whose modes of functioning these laws express. The general principle is that in a new environment there is an evolution of the old entities into new forms.

This rapid outline of a thoroughgoing organic theory of nature enables us to understand the chief requisites of the doctrine of evolution. The main work, proceeding during this pause at the end of the nineteenth century, was the absorption of this doctrine as guiding the methodology of all branches of science. By a blindness which is almost judicial as being a penalty affixed to hasty, superficial thinking, many religious thinkers opposed the new doctrine; although, in truth, a thoroughgoing evolutionary philosophy is inconsistent with materialism. The aboriginal stuff, or material, from which a materialistic philosophy starts is incapable of evolution. This material is in itself the ultimate substance. Evolution, on the materialistic theory, is reduced to the rôle of being another word for the description of the changes of the external relations between portions of matter. There is nothing to evolve, because one set of external relations is as good as any other set of external relations. There can merely be change, purposeless and unprogressive. But the whole point of the modern doctrine is the evolution of the complex organisms from antecedent states of less complex organisms. The doctrine thus cries aloud for a conception of organism as fundamental for nature. It also requires an underlying activity—a substantial activity—expressing itself in individual embodiments, and evolving in achievements of organism. The organism is a unit of emergent value, a real fusion of the characters of eternal objects, emerging for its own sake.

Thus in the process of analysing the character of nature in itself, we find that the emergence of organisms depends on a selective activity which is akin to purpose. The point is that the enduring organisms are now the outcome of evolution; and that, beyond these organisms, there is nothing else that endures. On the materialistic theory, there is material—such as matter or electricity—which endures. On the organic theory, the only endurances are structures of activity, and the structures are evolved.

Enduring things are thus the outcome of a temporal process; whereas eternal things are the elements required for the very being of the process. We can give a precise definition of endurance in this way: Let an event A be pervaded by an enduring structural pattern. Then A can be exhaustively subdivided into a temporal succession of events. Let B be any part of A, which is obtained by picking out any one of the events belonging to a series which thus subdivides A. Then the enduring pattern is a pattern of aspects within the complete pattern prehended into the unity of A, and it is also a pattern within the complete pattern prehended into the unity of any temporal slice of A, such as B. For example, a molecule is a pattern exhibited in an event of one minute, and of any second of that minute. It is obvious that such an enduring pattern may be of more, or of less, importance. It may express some slight fact connecting the underlying activities thus individualised; or it may express some very close connection. If the pattern which endures is merely derived from the direct aspects of the external environment, mirrored in the standpoints of the various parts, then the endurance is an extrinsic fact of slight importance. But if the enduring pattern is wholly derived from the direct aspects of the various temporal sections of the event in question, then the endurance is an important intrinsic fact. It expresses a certain unity of character uniting the underlying individualised activities. There is then an enduring object with a certain unity for itself and for the rest of nature. Let us use the term physical endurance to express endurance of this type. Then physical endurance is the process of continuously inheriting a certain identity of character transmitted throughout a historical route of events. This character belongs to the whole route, and to every event of the route. This is the exact property of material. If it has existed for ten minutes, it has existed during every minute of the ten minutes, and during every second of every minute. Only if you take *material* to be

fundamental, this property of endurance is an arbitrary fact at the base of the order of nature; but if you take *organism* to be fundamental, this property is the result of evolution.

It looks at first sight, as if a physical object, with its process of inheritance from itself, were independent of the environment. But such a conclusion is not justified. For let *B* and *C* be two successive slices in the life of such an object, such that *C* succeeds *B*. Then the enduring pattern in *C* is inherited from *B*, and from other analogous antecedent parts of its life. It is transmitted through *B* to *C*. But what is transmitted to *C* is the complete pattern of aspects derived from such events as *B*. These complete patterns include the influence of the environment on *B*, and on the other antecedent parts of the life of the object. Thus the complete aspects of the antecedent life are inherited as the partial pattern which endures throughout all the various periods of the life. Thus a favourable environment is essential to the maintenance of a physical object.

Nature, as we know it, comprises enormous permanences. There are the permanences of ordinary matter. The molecules within the oldest rocks known to geologists may have existed unchanged for over a thousand million years, not only unchanged in themselves, but unchanged in their relative dispositions to each other. In that length of time the number of pulsations of a molecule vibrating with the frequency of yellow sodium light would be about $16.3 \times 10^{22} = 163{,}000 \times (10^6)^3$. Until recently, an atom was apparently indestructible. We know better now. But the indestructible atom has been succeeded by the apparently indestructible electron and the indestructible proton.

Another fact to be explained is the great similarity of these practically indestructible objects. All electrons are very similar to each other. We need not outrun the evidence, and say that they are identical; but our powers of observation cannot detect any differences. Analogously, all hydrogen nuclei are alike. Also we note the great numbers of these analogous objects. There are throngs of them. It seems as though a certain similarity were a favourable condition for endurance. Common sense also suggests this conclusion. If organisms are to survive, they must work together.

Accordingly, the key to the mechanism of evolution is the necessity for the evolution of a favourable environment, conjointly with the evolution of any specific type of enduring organisms of great

permanence. Any physical object which by its influence deteriorates its environment, commits suicide.

One of the simplest ways of evolving a favourable environment concurrently with the development of the individual organism, is that the influence of each organism on the environment should be favourable to the *endurance* of other organisms of the same type. Further, if the organism also favours the *development* of other organisms of the same type, you have then obtained a mechanism of evolution adapted to produce the observed state of large multitudes of analogous entities, with high powers of endurance. For the environment automatically develops with the species, and the species with the environment.

The first question to ask is, whether there is any direct evidence for such a mechanism for the evolution of enduring organisms. In surveying nature, we must remember that there are not only basic organisms whose ingredients are merely aspects of eternal objects. There are also organisms of organisms. Suppose for the moment and for the sake of simplicity, we assume, without any evidence, that electrons and hydrogen nuclei are such basic organisms. Then the atoms, and the molecules, are organisms of a higher type, which also represent a compact definite organic unity. But when we come to the larger aggregations of matter, the organic unity fades into the background. It appears to be but faint and elementary. It is there; but the pattern is vague and indecisive. It is a mere aggregation of effects. When we come to living beings, the definiteness of pattern is recovered, and the organic character again rises into prominence. Accordingly, the characteristic laws of inorganic matter are mainly the statistical averages resulting from confused aggregates. So far are they from throwing light on the ultimate nature of things, that they blur and obliterate the individual characters of the individual organisms. If we wish to throw light upon the facts relating to organisms, we must study either the individual molecules and electrons, or the individual living beings. In between we find comparative confusion. Now the difficulty of studying the individual molecule is that we know so little about its life history. We cannot keep an individual under continuous observation. In general, we deal with them in large aggregates. So far as individuals are concerned, sometimes with difficulty a great experimenter throws, so to speak, a flash light on one of them, and just observes one type of instantaneous

effect. Accordingly, the history of the functioning of individual molecules, or electrons, is largely hidden from us.

But in the case of living beings, we can trace the history of individuals. We now find exactly the mechanism which is here demanded. In the first place, there is the propagation of the species from members of the same species. There is also the careful provision of the favourable environment for the endurance of the family, the race, or the seed in the fruit.

It is evident, however, that I have explained the evolutionary mechanism in terms which are far too simple. We find associated species of living things, providing for each other a favourable environment. Thus just as the members of the same species mutually favour each other, so do members of associated species. We find the rudimentary fact of association in the existence of the two species, electrons and hydrogen nuclei. The simplicity of the dual association, and the apparent absence of competition from other antagonistic species account for the massive endurance which we find among them.

There are thus two sides to the machinery involved in the development of nature. On one side, there is a given environment with organisms adapting themselves to it. The scientific materialism of the epoch in question emphasised this aspect. From this point of view, there is a given amount of material, and only a limited number of organisms can take advantage of it. The givenness of the environment dominates everything. Accordingly, the last words of science appeared to be the Struggle for Existence, and Natural Selection. Darwin's own writings are for all time a model of refusal to go beyond the direct evidence, and of careful retention of every possible hypothesis. But those virtues were not so conspicuous in his followers, and still less in his camp-followers. The imagination of European sociologists and publicists was strained by exclusive attention to this aspect of conflicting interests. The idea prevailed that there was a peculiar strongminded realism in discarding ethical considerations in the determination of the conduct of commercial and national interests.

The other side of the evolutionary machinery, the neglected side, is expressed by the word *creativeness*. The organisms can create their own environment. For this purpose, the single organism is almost helpless. The adequate forces require societies of coöperating

organisms. But with such coöperation and in proportion to the effort put forward, the environment has a plasticity which alters the whole ethical aspect of evolution.

In the immediate past, and at present, a muddled state of mind is prevalent. The increased plasticity of the environment for mankind, resulting from the advances in scientific technology, is being construed in terms of habits of thought which find their justification in the theory of a fixed environment.

The riddle of the universe is not so simple. There is the aspect of permanence in which a given type of attainment is endlessly repeated for its own sake; and there is the aspect of transition to other things—it may be of higher worth, and it may be of lower worth. Also there are its aspects of struggle and of friendly help. But romantic ruthlessness is no nearer to real politics, than is romantic self-abnegation.

Religion in the Making

Chapter I Religion in History 471
Chapter II Religion and Dogma 483
Chapter III Body and Spirit 497
Chapter IV Truth and Criticism 512

RELIGION IN THE MAKING

Religion in the Making, the Lowell Institute Lectures for 1926, is here reprinted in its entirety. From Science and the Modern World down to his last publication, nearly all of Whitehead's work deals to some extent with the central concepts of religion, theology, and metaphysics. Although these various different treatments vary both in detail and in emphasis, there does not seem to be in any of them any fundamental discrepancy with the general theory as expressed in Religion in the Making. For further development of the themes introduced here the reader's attention is called to Chapters XI and XII of Science and the Modern World, Part V of Process and Reality, and Part IV of Adventures of Ideas.

In a sense these four lectures can be considered as a development of the theme of the interdependence of science, philosophy, and religion which Whitehead sketches out briefly in the concluding sections of Chapter I of Part I of Process and Reality. Just as in his works on the philosophy of science Whitehead sought in experience the roots of the scientific concepts, so here he seeks the basis of religious concepts in religious experience and traces the growth of dogmatic theology from those roots.

CHAPTER I *RELIGION IN HISTORY*

I. RELIGION DEFINED

It is my purpose in the four lectures of this course to consider the type of justification which is available for belief in doctrines of religion. This is a question which in some new form challenges each generation. It is the peculiarity of religion that humanity is always shifting its attitude towards it.

The contrast between religion and the elementary truths of arithmetic makes my meaning clear. Ages ago the simple arithmetical doctrines dawned on the human mind, and throughout history the unquestioned dogma that two and three makes five reigned whenever it has been relevant. We all know what this doctrine means, and its history is of no importance for its elucidation.

But we have the gravest doubt as to what religion means so far as doctrine is concerned. There is no agreement as to the definition of religion in its most general sense, including true and false religion; nor is there any agreement as to the valid religious beliefs, nor even as to what we mean by the truth of religion. It is for this reason that some consideration of religion as an unquestioned factor throughout the long stretch of human history is necessary to secure the relevance of any discussion of its general principles.

There is yet another contrast. What is generally disputed is doubtful, and what is doubtful is relatively unimportant—other things being equal. I am speaking of general truths. We avoid guiding our actions by general principles which are entirely unsettled. If we do not know what number is the product of 69 and 67, we defer any action pre-supposing the answer, till we have found out. This little arithmetical puzzle can be put aside till it is settled, and it is capable of definite settlement with adequate trouble.

But as between religion and arithmetic, other things are not equal. You *use* arithmetic, but you *are* religious. Arithmetic of course enters into your nature, so far as that nature involves a multiplicity of things. But it is there as a necessary condition, and not as a transforming agency. No one is invariably 'justified' by his faith in the multiplication table. But in some sense or other, justification is the basis of all religion. Your character is developed according to your

faith. This is the primary religious truth from which no one can escape. Religion is force of belief cleansing the inward parts. For this reason the primary religious virtue is sincerity, a penetrating sincerity.

A religion, on its doctrinal side, can thus be defined as a system of general truths which have the effect of transforming character when they are sincerely held and vividly apprehended.

In the long run your character and your conduct of life depend upon your intimate convictions. Life is an internal fact for its own sake, before it is an external fact relating itself to others. The conduct of external life is conditioned by environment, but it receives its final quality, on which its worth depends, from the internal life which is the self-realization of existence. Religion is the art and the theory of the internal life of man, so far as it depends on the man himself and on what is permanent in the nature of things.

This doctrine is the direct negation of the theory that religion is primarily a social fact. Social facts are of great importance to religion, because there is no such thing as absolutely independent existence. You cannot abstract society from man; most psychology is herd-psychology. But all collective emotions leave untouched the awful ultimate fact, which is the human being, consciously alone with itself, for its own sake.

Religion is what the individual does with his own solitariness. It runs through three stages, if it evolves to its final satisfaction. It is the transition from God the void to God the enemy, and from God the enemy to God the companion.

Thus religion is solitariness; and if you are never solitary, you are never religious. Collective enthusiasms, revivals, institutions, churches, rituals, bibles, codes of behaviour, are the trappings of religion, its passing forms. They may be useful, or harmful; they may be authoritatively ordained, or merely temporary expedients. But the end of religion is beyond all this.

Accordingly, what should emerge from religion is individual worth of character. But worth is positive or negative, good or bad. Religion is by no means necessarily good. It may be very evil. The fact of evil, interwoven with the texture of the world, shows that in the nature of things there remains effectiveness for degradation. In your religious experience the God with whom you have made terms may be the God of destruction, the God who leaves in his wake the loss of the greater reality.

In considering religion, we should not be obsessed by the idea of its necessary goodness. This is a dangerous delusion. The point to notice is its transcendent importance; and the fact of this importance is abundantly made evident by the appeal to history.

II. THE EMERGENCE OF RELIGION

Religion, so far as it receives external expression in human history, exhibits four factors or sides of itself. These factors are ritual, emotion, belief, rationalization. There is definite organized procedure, which is ritual: there are definite types of emotional expression: there are definitely expressed beliefs: and there is the adjustment of these beliefs into a system, internally coherent and coherent with other beliefs.

But all these four factors are not of equal influence throughout all historical epochs. The religious idea emerged gradually into human life, at first barely disengaged from other human interests. The order of the emergence of these factors was in the inverse order of the depth of their religious importance: first ritual, then belief, then rationalization.

The dawn of these religious stages is gradual. It consists in an increase of emphasis. Perhaps it is untrue to affirm that the later factors are ever wholly absent. But certainly, when we go far enough back, belief and rationalization are completely negligible, and emotion is merely a secondary result of ritual. Then emotion takes the lead, and the ritual is for the emotion which it generates. Belief then makes its appearance as explanatory of the complex of ritual and emotion, and in this appearance of belief we may discern the germ of rationalization.

It is not until belief and rationalization are well established that solitariness is discernible as constituting the heart of religious importance. The great religious conceptions which haunt the imaginations of civilized mankind are scenes of solitariness: Prometheus chained to his rock, Mahomet brooding in the desert, the meditations of the Buddha, the solitary Man on the Cross. It belongs to the depth of the religious spirit to have felt forsaken, even by God.

III. RITUAL AND EMOTION

Ritual goes back beyond the dawn of history. It can be discerned in the animals, in their individual habits and still more in their collective evolutions. Ritual may be defined as the habitual performance

of definite actions which have no direct relevance to the preservation of the physical organisms of the actors.

Flocks of birds form their ritual evolutions in the sky. In Europe rooks and starlings are notable examples of this fact. Ritual is the primitive outcome of superfluous energy and leisure. It exemplifies the tendency of living bodies to repeat their own actions. Thus the actions necessary in hunting for food, or in other useful pursuits, are repeated for their own sakes; and their repetition also repeats the joy of exercise and the emotion of success.

In this way emotion waits upon ritual; and then ritual is repeated and elaborated for the sake of its attendant emotions. Mankind became artists in ritual. It was a tremendous discovery—how to excite emotions for their own sake, apart from some imperious biological necessity. But emotions sensitize the organism. Thus the unintended effect was produced of sensitizing the human organism in a variety of ways diverse from what would have been produced by the necessary work of life.

Mankind was started upon its adventures of curiosity and of feeling.

It is evident that, according to this account, religion and play have the same origin in ritual. This is because ritual is the stimulus to emotion, and an habitual ritual may diverge into religion or into play, according to the quality of the emotion excited. Even in comparatively modern times, among the Greeks of the fifth century before Christ, the Olympic Games were tinged with religion, and the Dionysiac festival in Attica ended with a comic drama. Also in the modern world, a holy day and a holiday are kindred notions.

Ritual is not the only way of artificially stimulating emotion. Drugs are equally effective. Luckily the range of drugs at the command of primitive races was limited. But there is ample evidence of the religious use of drugs in conjunction with the religious use of ritual. For example Athenæus tells us that among the Persians it was the religious duty of the King, once a year, at some stated festival in honour of Mithras, to appear in the temple intoxicated.* A relic of the religious awe at intoxication is the use of wine in the Communion service. It is an example of the upward trend of ritual by which a widespread association of thought is elevated into a great symbolism, divested of its primitive grossness.

* Cf. *The Deipnosophistæ of Athenæus,* Book X. I am indebted to my friend Professor J. H. Woods for this reference.

In this primitive phase of religion, dominated by ritual and emotion, we are dealing with essentially social phenomena. Ritual is more impressive, and emotion more active, when a whole society is concerned in the same ritual and the same emotion. Accordingly, a collective ritual and a collective emotion take their places as one of the binding forces of savage tribes. They represent the first faint glimmerings of the life of the spirit raised beyond concentration upon the task of supplying animal necessities. Conversely, religion in its decay sinks back into sociability.

IV. BELIEF

Mere ritual and emotion cannot maintain themselves untouched by intellectuality. Also the abstract idea of maintaining the ritual for the sake of the emotion, though it may express the truth about the subconscious psychology of primitive races, is far too abstract to enter into their conscious thoughts. A myth satisfies the demands of incipient rationality. Men found themselves practising various rituals, and found the rituals generating emotions. The myth explains the purpose both of the ritual and of the emotion. It is the product of the vivid fancy of primitive men in an unfathomed world.

To primitive man, and to ourselves on our primitive side, the universe is not so much unfathomable as unfathomed—by this I mean undiscriminated, unanalyzed. It is not a complex of definite unexplained happenings, but a dim background shot across by isolated vivid effects charged with emotional excitements. The very presuppositions of a coherent rationalism are absent. Such a rationalism presupposes a complex of definite facts whose interconnections are sought. But the prior stage is a background of indefiniteness relieved by vivid acts of definition, inherently isolated. One exception must be made in favour of the routine of tribal necessities which are taken for granted. But what lies beyond the routine of life is in general void of definition; and when it is vivid, it is disconnected.

The myth which meets the ritual is some exceptional vivid fancy, or recollection of some actual vivid fact—probably distorted in remembrance—which appears not only as explanatory both of ritual and emotion, but also as generative of emotion when conjoined with the ritual. Thus the myth not only explains but reinforces the hidden purpose of the ritual, which is emotion.

Then rituals and emotions and myths reciprocally interact; and the

myths have various grades of relationship to actual fact, and have various grades of symbolic truth as being representative of large ideas only to be apprehended in some parable. Also in some cases the myth precedes the ritual. But there is the general fact that ritualism precedes mythology. For we can observe ritualism even among animals, and presumably they are destitute of a mythology.

A myth will involve special attention to some persons or to some things, real or imaginary. Thus in a sense, the ritual, as performed in conjunction with the explanatory purpose of the myth, is the primitive worship of the hero-person or the hero-thing. But there can be very little disinterested worship among primitive folk—even less than now, is possible. Accordingly, the belief in the myth will involve the belief that something is to be got out of him or it, or that something is to be averted in respect to the evil to be feared from him or it. Thus incantation, prayer, praise, and the ritual absorption of the hero deity emerge.

If the hero be a person, we call the ritual, with its myth, 'religion'; if the hero be a thing, we call it 'magic.' In religion we induce, in magic we compel. The important difference between magic and religion is that magic is unprogressive and religion sometimes is progressive; except in so far as science can be traced back to the progress of magic.

Religion, in this stage of belief, marks a new formative agent in the ascent of man. For just as ritual encouraged *emotion* beyond the mere response to practical necessities, so religion in this further stage begets *thoughts* divorced from the mere battling with the pressure of circumstances. Imagination secured in it a machinery for its development; thought has been thereby led beyond the immediate objects in sight. Its concepts may in these early stages be crude and horrible; but they have the supreme virtue of being concepts of objects beyond immediate sense and perception.

This is the stage of uncoördinated beliefs. So far as this is the dominant phase there can be a curious tolerance, in that one cult does not war upon another cult. Since there is a minimum of coördination, there is room for all. But religion is still a thoroughly social phenomenon. The cult includes the tribe, or at least it includes some well-defined body of persons within the social organism. You may not desert your own cults, but there need be no clash between cults. In the higher stages of such a religion there are tribal gods, or many

gods within a tribe, with the loosest coördination of cults and myths.

Though religion can be a source of progress, it need not be so, especially when its dominant feature is this stage of uncriticized belief. It is easy for a tribe to stabilize its ritual and its myths, and there need be no external spur to progress. In fact, this is the stage of religious evolution in which the masses of semi-civilized humanity have halted—the stage of satisfactory ritual and of satisfied belief without impulse towards higher things. Such religion satisfies the pragmatic test: It works, and thereby claims that it be awarded the prize for truth.

V. RATIONALISM

The age of martyrs dawns with the coming of rationalism. The antecedent phases of religion had been essentially sociable. Many were called, and all were chosen. The final phase introduces the note of solitariness: 'Strait is the gate, and narrow is the way, . . . and few there be that find it.' When a modern religion forgets this saying, it is suffering from an atavistic relapse into primitive barbarism. It is appealing to the psychology of the herd, away from the intuitions of the few.

The religious epoch which we are now considering is very modern. Its past duration is of the order of six thousand years. Of course exact dates do not count; you can extend the epoch further back into the past in order to include some faint anticipatory movement, or you can contract its duration so as to exclude flourishing survivals of the earlier phase. The movement has extended over all the civilized races of Asia and Europe. In the past Asia has proved the most fertile in ideas, but within the last two thousand years Europe has given the movement a new aspect. It is to be noted that the two most perfect examples of rationalistic religions have flourished chiefly in countries foreign to the races among which they had their origin.

The Bible is by far the most complete account of the coming of rationalism into religion, based on the earliest documents available. Viewed as such an account, it is only relevant to the region between the Tigris and the Nile. It exhibits the note of progressive solitariness in the religious idea: first, types of thought generally prevalent; then protesting prophets, isolated figures of denunciation and exhortation stirring the Jewish nation; then one man, with twelve disciples, who met with almost complete national rejection; then the adaptation for

popular survival of this latter doctrine by another man who, very significantly, had no first-hand contact with the original teaching. In his hands, something was added and something was lost; but fortunately the Gospels also survive.

It is evident that I have drawn attention to the span of six thousand years because, in addition to being reasonable when we have regard to all the evidence, it corresponds to the chronology of the Bible. We—in Europe and America—are the heirs of the religious movements depicted in that collection of books. Discussion on the methods of religion and their justification must, in order to be relevant, base itself upon the Bible for illustration. We must remember, however, that Buddhism and Mahometanism, among others, must also be included in the scope of general statements, even if they are not explicitly referred to.

Rational religion is religion whose beliefs and rituals have been reorganized with the aim of making it the central element in a coherent ordering of life—an ordering which shall be coherent both in respect to the elucidation of thought, and in respect to the direction of conduct towards a unified purpose commanding ethical approval.

The peculiar position of religion is that it stands between abstract metaphysics and the particular principles applying to only some among the experiences of life. The relevance of its concepts can only be distinctly discerned in moments of insight, and then, for many of us, only after suggestion from without. Hence religion bases itself primarily upon a small selection from the common experiences of the race. On this side, religion ranges itself as one among other specialized interests of mankind whose truths are of limited validity. But on its other side, religion claims that its concepts, though derived primarily from special experiences, are yet of universal validity, to be applied by faith to the ordering of all experience.

Rational religion appeals to the direct intuition of special occasions, and to the elucidatory power of its concepts for all occasions. It arises from that which is special, but it extends to what is general. The doctrines of rational religion aim at being that metaphysics which can be derived from the supernatural experience of mankind in its moments of finest insight. Theoretically, rational religion could have arisen in complete independence of the antecedent social religions of ritual and mythical belief. Before the historical sense had established

itself, that was the way in which the apologetic theologians tended to exhibit the origins of their respective religions. But the general history of religion, and in particular that portion of its history contained in the Bible, decisively negatives that view. Rational religion emerged as a gradual transformation of the preëxisting religious forms. Finally, the old forms could no longer contain the new ideas, and the modern religions of civilization are traceable to definite crises in this process of development. But the development was not then ended; it had only acquired more suitable forms for self-expression.

The emergence of rational religion was strictly conditioned by the general progress of the races in which it arose. It had to wait for the development in human consciousness of the relevant general ideas and of the relevant ethical intuitions. It required that such ideas should not merely be casually entertained by isolated individuals, but that they should be stabilized in recognizable forms of expression, so as to be recalled and communicated. You can only speak of mercy among a people who, in some respects, are already merciful.

A language is not a universal mode of expressing all ideas whatsoever. It is a limited mode of expressing such ideas as have been frequently entertained, and urgently needed, by the group of human beings who developed that mode of speech. It is only during a comparatively short period of human history that there has existed any language with an adequate stock of general terms. Such general terms require a permanent literature to define them by their mode of employment.

The result is that the free handling of general ideas is a late acquirement. I am not maintaining that the brains of men were inadequate for the task. The point is that it took ages for them to develop first the appliances and then the habits which made generality of thought possible and prevalent. For ages, existing languages must have been ready for development. If men had been in contact with a superior race, either personally or by a survival of their literature, a process which requires scores or even hundreds of generations might have been antedated, so as to have been effected almost at once. Such, in fact, was the later history of the development of the races of Northern Europe. Again, a social system which encourages developments of thought can procure the advent. This is the way in which the result was first obtained. Society and language grew together.

The influence of the antecedent type of religion, ceremonial, mythi-

cal, and sociable, has been great; and the estimates as to its value diverse. During the thousand years preceding the Christian era, there was a peculiarly intense struggle on the part of rationalism to transform the more primitive type. The issue was a new synthesis which, in the forms of the various great religions, has lasted to the present day. A rational generality was introduced into the religious ideas; and the myth, when retained, was reorganized with the intention of making it an account of verifiable historical circumstances which exemplified the general ideas with adequate perfection.

Thus rational criticism was admitted in principle. The appeal was from the tribal custom to the direct individual intuition, ethical, metaphysical, or logical: 'For I desired mercy, and not sacrifice; and the knowledge of God more than burnt offerings,' are words which Hosea ascribes to Jehovah; and he thereby employs the principles of individual criticism of tribal custom, and bases it upon direct ethical intuition.

In this way the religions evolved towards more individualistic forms, shedding their exclusively communal aspect. The individual became the religious unit in the place of the community; the tribal dance lost its importance compared to the individual prayer; and, for the few, the individual prayer merged into justification through individual insight.

So to-day it is not France which goes to heaven, but individual Frenchmen; and it is not China which attains nirvana, but Chinamen.

During this epoch of struggle—as in most religious struggles—the judgments passed by the innovators on the less-developed religious forms were very severe. The condemnation of idolatry pervades the Bible; and there are traces of a recoil which go further: 'I hate, I despise your feast days,' writes Amos, speaking in the name of Jehovah.

Such criticism is wanted. Indeed history, down to the present day, is a melancholy record of the horrors which can attend religion: human sacrifice, and in particular the slaughter of children, cannibalism, sensual orgies, abject superstition, hatred as between races, the maintenance of degrading customs, hysteria, bigotry, can all be laid at its charge. Religion is the last refuge of human savagery. The uncritical association of religion with goodness is directly negatived by plain facts. Religion can be, and has been, the main instrument for progress. But if we survey the whole race, we must pronounce

that generally it has not been so: 'Many are called, but few are chosen.'

VI. THE ASCENT OF MAN

At different epochs in history new factors emerge and successively assume decisive importance in their influence on the ascent, or the descent, of races of mankind. Within the millennium preceding the birth of Christ, the communal religions were ceasing to be engines of progress. On the whole, they had served humanity well. By their agency, the sense of social unity and of social responsibility had been quickened. The common cult gave expression to the emotion of being a hundred per cent tribal. The explicit emotions of a life finding its interest in activities not directed to its own preservation were fostered by them. Also they produced concrete beliefs which embodied, however waveringly, the justification for these emotions.

But at a certain stage in history, though still elements in the preservation of the social structure, they ceased to be engines of progress. Their work was done.

They were salving the old virtues which had made the race the great society that it had been, and were not straining forward towards the new virtues to make the common life the City of God that it should be. They were religions of the average, and the average is at war with the ideal.

Human thought had broken through the limited horizon of the one social structure. The world as a whole entered into the explicit consciousness. The facility for individual wandering in comparative safety produced this enlargement of thought. A tribe which is wandering as a unit amid dangers may pick up new ideas, but it will strengthen its sense of tribal unity in the face of a hostile environment.

But an individual who travels meets strangers on terms of kindliness. He returns home, and in his person and by his example promotes the habit of thinking dispassionately beyond the tribe. The history of rational religion is full of tales of disengagement from the immediate social routine. If we keep to the Bible: Abraham wandered, the Jews were carried off to Babylon and after two generations were allowed to return peacefully, St. Paul's conversion was on a journey, and his theology was elaborated amid travels. This millennium was an age of travel; among the Greeks, Herodotus, Thucydides, Plato, Xenophon, Aristotle, exemplify their times. The great empires and

trading facilities made travelling easy; everyone travelled and found the world fresh and new. A world-consciousness was produced.

In India and China the growth of a world-consciousness was different in its details, but in its essence depended on the same factors. Individuals were disengaged from their immediate social setting in ways which promoted thought.

Now, so far as concerns religion, the distinction of a world-consciousness as contrasted with a social consciousness is the change of emphasis in the concept of rightness. A social consciousness concerns people whom you know and love individually. Hence, rightness is mixed up with the notion of preservation. Conduct is right which will lead some god to protect you; and it is wrong if it stirs some irascible being to compass your destruction. Such religion is a branch of diplomacy. But a world-consciousness is more disengaged. It rises to the conception of an essential rightness of things. The individuals are indifferent, because unknown. The new, and almost profane, concept of the goodness of God replaces the older emphasis on the will of God. In a communal religion you study the will of God in order that He may preserve you; in a purified religion, rationalized under the influence of the world-concept, you study his goodness in order to be like him. It is the difference between the enemy you conciliate and the companion whom you imitate.

VII. THE FINAL CONTRAST

A survey of religious history has disclosed that the coming of rational religion is the consequence of the growth of a world-consciousness. The later phases of the antecedent communal type of religion are dominated by the conscious reaction of human nature to the social organization in which it finds itself. Such reaction is partly emotion clothing itself in belief and ritual, and partly reason justifying practice by the test of social preservation. Rational religion is the wider conscious reaction of men to the universe in which they find themselves.

Communal religion broadened itself to the verge of rationalism. In its last stages in the Western World we find the religion of the Roman Empire, in which the widest possible view of the social structure is adopted. The cult of the Empire was the sort of religion which might be constructed to-day by the Law School of a University, laudably impressed by the notion that mere penal repression is not

the way to avert a crime wave. Indeed, if we study the mentality of the Emperor Augustus and of the men who surrounded him, this is not far off from the true description of its final step in evolution.

Another type of modified communal religion was reached by the Jews. Their religion embodied general ideas as to the nature of things which were entirely expressed in terms of their relevance to the Jewish race. This compromise was very effective, but very unstable. It is a type of religious settlement to which communities are always reverting. In the modern world it is the religion of emotional statesmen, captains of industry, and social reformers. In the case of the Jews the crises to which it led were the birth of Christianity, and the forcible dispersion of the Jews by the military might of Rome. The same type of religion in our generation was one of the factors which led to the great war. It leads to the morbid exaggeration of national self-consciousness. It lacks the element of quietism. Generality is the salt of religion.

When Christianity had established itself throughout the Roman Empire and its neighbourhood, there were before the world two main rational religions, Buddhism and Christianity. There were, of course, many rivals to both of them in their respective regions; but if we have regard to clarity of idea, generality of thought, moral respectability, survival power, and width of extension over the world, then for their combination of all these qualities these religions stood out beyond their competitors. Later their position was challenged by the Mahometans. But even to-day, the two Catholic religions of civilization are Christianity and Buddhism, and—if we are to judge by the comparison of their position now with what it has been—both of them are in decay. They have lost their ancient hold upon the world.

CHAPTER II *RELIGION AND DOGMA*

I. THE RELIGIOUS CONSCIOUSNESS IN HISTORY

The great rational religions are the outcome of the emergence of a religious consciousness which is universal, as distinguished from tribal, or even social. Because it is universal, it introduces the note

of solitariness. Religion is what the individual does with his solitariness.

The reason of the connection between universality and solitariness is that universality is a disconnection from immediate surroundings. It is an endeavour to find something permanent and intelligible by which to interpret the confusion of immediate detail.

This element of detachment in religion is more particularly exhibited in the great reflective books of the Old Testament. In this group of books we find a conscious search after general principles. In other books, current ideas are assumed and are applied to the troubles of what was then the immediate present. Such books exemplify the state of thought of their times as in controversy, but they do not exhibit a process of reflective formation.

In the reflective books the effort is not to reform society, or even to express religious emotion. There is a self-conscious endeavour to apprehend some general principles.

In the book of Job we find the picture of a man suffering from an almost fantastic array of the evils characteristic of his times. He is tearing to pieces the sophism that all is for the best in the best of possible worlds, and that the justice of God is beautifully evident in everything that happens. The essence of the book of Job is the contrast of a general principle, or dogma, and the particular circumstances to which it should apply. There is also throughout the book the undercurrent of fear lest an old-fashioned tribal god might take offense at this rational criticism.

No religion which faces facts can minimize the evil in the world, not merely the moral evil, but the pain and the suffering. The book of Job is the revolt against the facile solution, so esteemed by fortunate people, that the sufferer is the evil person.

Both the great religions, Christianity and Buddhism, have their separate set of dogmas which deal with this great question. It is in respect to the problem of evil that one great divergence between them exists. Buddhism finds evil essential in the very nature of the world of physical and emotional experience. The wisdom which it inculcates is, therefore, so to conduct life as to gain a release from the individual personality which is the vehicle for such experience. The Gospel which it preaches is the method by which this release can be obtained.

One metaphysical fact about the nature of things which it pre-

supposes is that this release is not to be obtained by mere physical death. Buddhism is the most colossal example in history of applied metaphysics.

Christianity took the opposite road. It has always been a religion seeking a metaphysic, in contrast to Buddhism which is a metaphysic generating a religion. The defect of a metaphysical system is the very fact that it is a neat little system of thought, which thereby over-simplifies its expression of the world. Christianity has, in its historical development, struggled with another difficulty, namely, the fact that it has no clear-cut separation from the crude fancies of the older tribal religions.

But Christianity has one advantage. It is difficult to develop Buddhism, because Buddhism starts with a clear metaphysical notion and with the doctrines which flow from it. Christianity has retained the easy power of development. It starts with a tremendous notion about the world. But this notion is not derived from a metaphysical doctrine, but from our comprehension of the sayings and actions of certain supreme lives. It is the genius of the religion to point at the facts and ask for their systematic interpretation. In the Sermon on the Mount, in the Parables, and in their accounts of Christ, the Gospels exhibit a tremendous fact. The doctrine may, or may not, lie on the surface. But what is primary is the religious fact. The Buddha left a tremendous doctrine. The historical facts about him are subsidiary to the doctrine.

In respect to its treatment of evil, Christianity is, therefore, less clear in its metaphysical ideas, but more inclusive of the facts. In the first place, it admits the evil as inherent throughout the world. But it holds that such evil is not the necessary outcome of the very fact of individual personality. It derives the evil from the contingent fact of the actual course of events; it thus allows of an ideal as conceivable in terms of what is actual.

Christianity, like Buddhism, preaches a doctrine of escape. It proclaims a doctrine whereby, through the treatment of evil, life is placed on a finer level. It overcomes evil with good. Buddhism makes itself probable by referring to its metaphysical theory. Christianity makes itself probable by referring to supreme religious moments in history.

Thus in respect to this crucial question of evil, Buddhism and Christianity are in entirely different attitudes in respect to doctrine.

Buddhism starts with the elucidatory dogmas; Christianity starts with the elucidatory facts.

The problem of evil is only one among the interests of rational religious thought. Another is the search after wisdom. In the Book of Proverbs, in Ecclesiastes, and, among the books of the Apocrypha, in the Wisdom of Solomon, and in Ecclesiasticus, we find the record of reflection upon general principles embodied in proverbs, reflective, witty, and homely.

The search after wisdom has its origin in generalizations from experience:

> Two things have I required of thee; deny me them not before I die:
> Remove far from me vanity and lies: give me neither poverty nor riches; feed me with food convenient for me:
> Lest I be full, and deny thee, and say, Who is the Lord? or lest I be poor, and steal, and take the name of my God in vain!
>
> (*Proverbs* xxx: 7, 8, 9)

The habit of reading the more exciting denunciations of the prophets is apt to conceal from us the amount of detached, middle-class common sense which also contributed to the religious tradition of the Jews. There is a keen appreciation of actual fact, even when the moral is not over-clear. For example:

> I returned, and saw under the sun, that the race is not to the swift, nor the battle to the strong, neither yet bread to the wise, nor yet riches to men of understanding, nor yet favour to men of skill; but time and chance happeneth to them all.
>
> (*Ecclesiastes* ix: 11)

These two quotations express incontestable general truths, verified by the cynical wisdom of ages; and yet they are religion at a very low temperature. The point, thus illustrated, is that a rational religion must not confine itself to moments of emotional excitement. It must find its verification at all temperatures. It must admit the wisdom of the golden mean, in its season and for those whom it can claim by right of possession; and it must admit "that time and chance happeneth to them all."

The collection of Psalms is not properly a reflective book. It is an expressive book. It expresses the emotions natural to states of mind hovering between a universal and a tribal religious conception. There is joy in the creative energy of a supreme ruler who is also a

tribal champion. There is the glorification of power, magnificent and barbaric:

> The earth is the Lord's, and the fulness thereof; the world, and they that dwell therein.
>
> Who is this King of glory? The Lord of hosts, he is the King of glory.
>
> (*Psalms* xxiv.)

Magnificent literature! But there is no solution here of the difficulties which haunted Job. This worship of glory arising from power is not only dangerous: it arises from a barbaric conception of God. I suppose that even the world itself could not contain the bones of those slaughtered because of men intoxicated by its attraction. This view of the universe, in the guise of an Eastern empire ruled by a glorious tyrant, may have served its purpose. In its historical setting, it marks a religious ascent. The psalm quoted gives us its noblest expression. The other side comes out in the psalms expressing hate, psalms now generally withdrawn from public worship. The glorification of power has broken more hearts than it has healed.

Buddhism and Christianity find their origins respectively in two inspired moments of history: the life of the Buddha, and the life of Christ. The Buddha gave his doctrine to enlighten the world: Christ gave his life. It is for Christians to discern the doctrine. Perhaps in the end the most valuable part of the doctrine of the Buddha is its interpretation of his life.

We do not possess a systematic detailed record of the life of Christ; but we do possess a peculiarly vivid record of the first response to it in the minds of the first group of his disciples after the lapse of some years, with their recollections, interpretations, and incipient formularizations.

What we find depicted is a thoroughgoing rationalization of the Jewish religion carried through with a boundless naivete, and motivated by a first-hand intuition into the nature of things.

The reported sayings of Christ are not formularized thought. They are descriptions of direct insight. The ideas are in his mind as immediate pictures, and not as analyzed in terms of abstract concepts. He sees intuitively the relations between good men and bad men; his expressions are not cast into the form of an analysis of the goodness and badness of man. His sayings are actions and not ad-

justments of concepts. He speaks in the lowest abstractions that language is capable of, if it is to be language at all and not the fact itself.

In the Sermon on the Mount, and in the Parables, there is no reasoning about the facts. They are seen with immeasurable innocence. Christ represents rationalism derived from direct intuition and divorced from dialectics.

The life of Christ is not an exhibition of over-ruling power. Its glory is for those who can discern it, and not for the world. Its power lies in its absence of force. It has the decisiveness of a supreme ideal, and that is why the history of the world divides at this point of time.

II. THE DESCRIPTION OF RELIGIOUS EXPERIENCE

The dogmas of religion are the attempts to formulate in precise terms the truths disclosed in the religious experience of mankind. In exactly the same way the dogmas of physical science are the attempts to formulate in precise terms the truths disclosed in the sense-perception of mankind.

In the previous section we have been considering religious experience in the concrete; we have now to define its general character. Some general descriptions of religion were given in the former lecture. It was stated that 'Religion is force of belief cleansing the inward parts'; and again, that 'Religion is the art and theory of the internal life of man, so far as it depends on the man himself, and on what is permanent in the nature of things': and again, 'Religion is what the individual does with his own solitariness.'

This point of the origin of rational religion in solitariness is fundamental. Religion is founded on the concurrence of three allied concepts in one moment of self-consciousness, concepts whose separate relationships to fact and whose mutual relations to each other are only to be settled jointly by some direct intuition into the ultimate character of the universe.

These concepts are:

1. That of the value of an individual for itself.
2. That of the value of the diverse individuals of the world for each other.
3. That of the value of the objective world which is a community derivative from the interrelations of its component in-

dividuals, and also necessary for the existence of each of these individuals.

The moment of religious consciousness starts from self-valuation, but it broadens into the concept of the world as a realm of adjusted values, mutually intensifying or mutually destructive. The intuition into the actual world gives a particular definite content to the bare notion of a principle determining the grading of values. It also exhibits emotions, purposes, and physical conditions, as subservient factors in the emergence of value.

In its solitariness the spirit asks, What, in the way of value, is the attainment of life? And it can find no such value till it has merged its individual claim with that of the objective universe. Religion is world-loyalty.

The spirit at once surrenders itself to this universal claim and appropriates it for itself. So far as it is dominated by religious experience, life is conditioned by this formative principle, equally individual and general, equally actual and beyond completed act, equally compelling recognition and permissive of disregard.

This principle is not a dogmatic formulation, but the intuition of immediate occasions as failing or succeeding in reference to the ideal relevant to them. There is a rightness attained or missed, with more or less completeness of attainment or omission.

This is a revelation of character, apprehended as we apprehend the characters of our friends. But in this case it is in apprehension of character permanently inherent in the nature of things.

There is a large concurrence in the negative doctrine that this religious experience does not include any direct intuition of a definite person, or individual. It is a character of permanent rightness, whose inherence in the nature of things modifies both efficient and final cause, so that the one conforms to harmonious conditions, and the other contrasts itself with an harmonious ideal. The harmony in the actual world is conformity with the character.

It is not true that every individual item of the universe conforms to this character in every detail. There will be some measure of conformity and some measure of diversity. The whole intuition of conformity and diversity forms the contrast which that item yields for the religious experience. So far as the conformity is incomplete, there is evil in the world.

The evidence for the assertion of general, though not universal, concurrence in the doctrine of no direct vision of a personal God, can only be found by a consideration of the religious thought in the civilized world. Here the sources of the evidence can only be indicated.

Throughout India and China religious thought, so far as it has been interpreted in precise form, disclaims the intuition of any ultimate personality substantial to the universe. This is true for Confucian philosophy, Buddhist philosophy, and Hindoo philosophy. There may be personal embodiments, but the substratum is impersonal.

Christian theology has also, in the main, adopted the position that there is no direct intuition of such an ultimate personal substratum for the world. It maintains the doctrine of the existence of a personal God as a truth, but holds that our belief in it is based upon inference. Most theologians hold that this inference is sufficiently obvious to be made by all men upon the basis of their individual personal experience. But, be this as it may, it is an inference and not a direct intuition. This is the general doctrine of those traditionalist churches which more especially claim the title of Catholic; and contrary doctrines have, I believe, been officially condemned by the Roman Catholic Church: for example, the religious philosophy of Rosmini.

Greek thought, when it began to scrutinize the traditional cults, took the same line. In some form or other all attempts to formulate the doctrines of a rational religion in ancient Greece took their stand upon the Pythagorean notion of a direct intuition of a righteousness in the nature of things, functioning as a condition, a critic, and an ideal. Divine personality was in the nature of an inference from the directly apprehended law of nature, so far as it *was* inferred. Of course, there were many cults of divine persons within the nature of things. The question in discussion concerns a divine person, substrate to the nature of things.

This question of the ultimate nature of direct religious experience is very fundamental to the religious situation of the modern world. In the first place, if you make religious experience to be the direct intuition of a personal being substrate to the universe, there is no widespread basis of agreement to appeal to. The main streams of religious thought start with direct contradictions to each other. For

those who proceed in this way, and it is a usual form of modern appeal, there is only one hope—to supersede reason by emotion. Then you can prove anything, except to reasonable people. But reason is the safeguard of the objectivity of religion: it secures for it the general coherence denied to hysteria.

Another objection against this appeal to such an intuition, merely experienced in exceptional moments, is that the intuition is thereby a function of these moments. Anything which explains the origin of such moments, in respect to their emotional accompaniments, can then fairly be taken to be an explanation of the intuition. Thus the intuition becomes a private psychological habit, and is without general evidential force. This is the psychological interpretation which is fatal to evidence unable to maintain itself at all emotional temperatures amid great variety of environment.

Here a distinction must be drawn. Intuitions may first emerge as distinguished in consciousness under exceptional circumstances. But when some distinct idea has been once experienced, or suggested, it should then have its own independence of irrelevancies. Thus we may not know some arithmetical truth, and require some exceptional help to detect it. But when known, arithmetic is a permanent possession. The psychological interpretation, assigning a merely personal significance, holds when objective validity is claimed for an intuition which is only experienced in a set of discrete circumstances of definite specific character. The intuition may be clearer under such circumstances, but it should not be confined to them.

The wisdom of the main stream of Christian theology in refusing to countenance the notion of a direct vision of a personal God is manifest. For there is no consensus. The subordinate gods of the unrationalized religions—the religions of the heathen, as they are called—are not to the point; and when the great rationalized religions are examined, the majority lies the other way. As soon, however, as it comes to a question of rational interpretation, numbers rapidly sink in importance. Reason mocks at majorities.

But there is a large consensus, on the part of those who have rationalized their outlook, in favour of the concept of a rightness in things, partially conformed to and partially disregarded. So far as there is conscious determination of actions, the attainment of this conformity is an ultimate premise by reference to which our

choice of immediate ends is criticised and swayed. The rational satisfaction or dissatisfaction in respect to any particular happening depends upon an intuition which is capable of being universalized. This universalization of what is discerned in a particular instance is the appeal to a general character inherent in the nature of things.

This intuition is not the discernment of a form of words, but of a type of character. It is characteristic of the learned mind to exalt words. Yet mothers can ponder many things in their hearts which their lips cannot express. These many things, which are thus known, constitute the ultimate religious evidence, beyond which there is no appeal.

III. GOD

To-day there is but one religious dogma in debate: What do you mean by 'God'? And in this respect, to-day is like all its yesterdays. This is the fundamental religious dogma, and all other dogmas are subsidiary to it.

There are three main simple renderings of this concept before the world:

1. The Eastern Asiatic concept of an impersonal order to which the world conforms. This order is the self-ordering of the world; it is not the world obeying an imposed rule. The concept expresses the extreme doctrine of immanence.

2. The Semitic concept of a definite personal individual entity, whose existence is the one ultimate metaphysical fact, absolute and underivative, and who decreed and ordered the derivative existence which we call the actual world. This Semitic concept is the rationalization of the tribal gods of the earlier communal religions. It expresses the extreme doctrine of transcendence.

3. The Pantheistic concept of an entity to be described in the terms of the Semitic concept, except that the actual world is a phase within the complete fact which is this ultimate individual entity. The actual world, conceived apart from God, is unreal. Its only reality is God's reality. The actual world has the reality of being a partial description of what God is. But in itself it is merely a certain mutuality of 'appearance,' which is a phase of the being of God. This is the extreme doctrine of monism.

It will be noticed that the Eastern Asiatic concept and the Pantheistic concept invert each other. According to the former concept,

when we speak of God we are saying something about the world; and according to the latter concept, when we speak of the world we are saying something about God.

The Semitic concept and the Eastern Asiatic concept are directly opposed to each other, and any mediation between them must lead to complexity of thought. It is evident that the Semitic concept can very easily pass over into the Pantheistic concept. In fact, the history of philosophical theology in various Mahometan countries—Persia, for instance—shows that this passage has often been effected.

The main difficulties which the Semitic concept has to struggle with are two in number. One of them is that it leaves God completely outside metaphysical rationalization. We know, according to it, that He is such a being as to design and create this universe, and there our knowledge stops. If we mean by his goodness that He is the one self-existent, complete entity, then He is good. But such goodness must not be confused with the ordinary goodness of daily life. He is undeniably useful, because anything baffling can be ascribed to his direct decree.

The second difficulty of the concept is to get itself proved. The only possible proof would appear to be the 'ontological proof' devised by Anselm, and revived by Descartes. According to this proof, the mere concept of such an entity allows us to infer its existence. Most philosophers and theologians reject this proof: for example, it is explicitly rejected by Cardinal Mercier in his Manual of Scholastic Philosophy.

Any proof which commences with the consideration of the character of the actual world cannot rise above the actuality of this world. It can only discover all the factors disclosed in the world as experienced. In other words, it may discover an immanent God, but not a God wholly transcendent. The difficulty can be put in this way: by considering the world we can find all the factors required by the total metaphysical situation; but we cannot discover anything not included in this totality of actual fact, and yet explanatory of it.

Christianity has not adopted any one of these clear alternatives. It has been true to its genius for keeping its metaphysics subordinate to the religious facts to which it appeals.

In the first place, it inherited the simple Semitic concept. All its founders naturally expressed themselves in those terms, and were addressing themselves to an audience who could only understand religion thus expressed.

But even here important qualifications have to be made. Christ himself introduces them. How far they were then new, or how far he is utilizing antecedent thoughts, is immaterial. The point is the decisive emphasis the notions receive in his teaching. The first point is the association of God with the Kingdom of Heaven, coupled with the explanation that 'The Kingdom of Heaven is within you.' The second point is the concept of God under the metaphor of a Father. The implications of this latter notion are expanded with moving insistence in the two Epistles by St. John, the author of the Gospel. To him we owe the phrase, 'God is love.'

Finally, in the Gospel of St. John, by the introduction of the doctrine of the Logos, a clear move is made towards the modification of the notion of the unequivocal personal unity of the Semitic God. Indeed, for most Christian Churches, the simple Semitic doctrine is now a heresy, both by reason of the modification of personal unity and also by the insistence on immanence.

The notion of immanence must be discriminated from that of omniscience. The Semitic God is omniscient; but, in addition to that, the Christian God is a factor in the universe. A few years ago a papyrus was found in an Egyptian tomb which proved to be an early Christian compilation called 'The Sayings of Christ.' Its exact authenticity and its exact authority do not concern us. I am quoting it as evidence of the mentality of many Christians in Egypt during the first few Christian centuries. At that date Egypt supplied the theological leaders of Christian thought. We find in these Logia of Christ the saying, 'Cleave the wood, and I am there.' This is merely one example of an emphatic assertion of immanence, and shows a serious divergence from the Semitic concept.

Immanence is a well-known modern doctrine. The points to be noticed are that it is implicit in various parts of the New Testament, and was explicit in the first theological epoch of Christianity. Christian theology was then Platonic; it followed John rather than Paul.

IV. THE QUEST OF GOD

The modern world has lost God and is seeking him. The reason for the loss stretches far back in the history of Christianity. In respect to its doctrine of God the Church gradually returned to the Semitic concept, with the addition of the threefold personality. It is a concept which is clear, terrifying, and unprovable. It was supported by

an unquestioned religious tradition. It was also supported by the conservative instinct of society, and by a history and a metaphysic both constructed expressly for that purpose. Moreover, to dissent was death.

On the whole, the Gospel of love was turned into a Gospel of fear. The Christian world was composed of terrified populations.

'The fear of the Lord is the beginning of knowledge,' says the Proverb (i.7). Yet this is an odd saying, if it be true that 'God is love.'

> 'In flaming fire taking vengeance on them that know not God, and that obey not the gospel of our Lord Jesus Christ'; says Paul.
>
> 'Who shall be punished with everlasting destruction from the presence of the Lord, and from the glory of his power.'
>
> (II *Thessalonians* i. 8, 9)

The populations did well to be terrified at such ambiguous good tidings, which lost no emphasis in their promulgation.

If the modern world is to find God, it must find him through love and not through fear, with the help of John and not of Paul. Such a conclusion is true and represents a commonplace of modern thought. But it is only a very superficial rendering of the facts.

As a rebound from dogmatic intolerance, the simplicity of religious truth has been a favorite axiom of liberalizing theologians. It is difficult to understand upon what evidence this notion is based. In the physical world as science advances, we discern a complexity of interrelations. There is a certain simplicity of dominant ideas, but modern physics does not disclose a simple world.

To reduce religion to a few simple notions seems an arbitrary solution of the problem before us. It may be common sense; but is it true? In view of the horrors produced by bigotry, it is natural for sensitive thinkers to minimize religious dogmas. But such pragmatic reasons are dangerous guides.

This procedure ends by basing religion on those few ideas which in the circumstances of the time are most effective in producing pleasing emotions and agreeable conduct. If our trust is in the ultimate power of reason as a discipline for the discernment of truth, we have no right to impose such *a priori* conditions. All simplifications of religious dogma are shipwrecked upon the rock of the problem of evil.

As a particular application, we may believe that the various doctrines about God have not suffered from their complexity. They have represented extremes of simplicity, so far as they have been formulated for the great rationalistic religions. The three extremes of simple notions should not represent in our eyes mutually exclusive concepts, from among which we are to choose one and reject the others.

It cannot be true that contradictory notions can apply to the same fact. Thus reconcilement of these contrary concepts must be sought in a more searching analysis of the meaning of the terms in which they are phrased.

The man who refused to admit that two and two make four, until he knew what use was to be made of this premise, had some justification. At a certain abstract level of thought, such statements are absolutely true. But once you desert that level, you admit fundamental transformations of meaning. Language cloaks the most profound ideas under its simplest words. For example, in 'two and two make four,' the words 'and' and 'make' entirely depend for their meaning upon the application which you are giving to the statement.

Analogously, in expressing our conception of God, words such as 'personal' and 'impersonal,' 'entity,' 'individuality,' 'actual,' require the closest careful watching, lest in different connections we should use them in different senses, not to speak of the danger of failing to use them in any determinate sense.

But it is impossible to fix the sense of fundamental terms except by reference to some definite metaphysical way of conceiving the most penetrating description of the universe.

Thus rational religion must have recourse to metaphysics for a scrutiny of its terms. At the same time it contributes its own independent evidence, which metaphysics must take account of in framing its description.

This mutual dependence is illustrated in all topics. For example, I have mentioned above that in modern Europe history and metaphysics have been constructed with the purpose of supporting the Semitic concept of God. To some extent this is justifiable, because both history and metaphysics must presuppose some canons by which to guide themselves.

The result is that you cannot confine any important reorganization

to one sphere of thought alone. You cannot shelter theology from science, or science from theology; nor can you shelter either of them from metaphysics, or metaphysics from either of them. There is no short cut to truth.

Religion, therefore, while in the framing of dogmas it must admit modifications from the complete circle of our knowledge, still brings its own contribution of immediate experience.

That contribution is in the first place the recognition that our existence is more than a succession of bare facts. We live in a common world of mutual adjustment, of intelligible relations, of valuations, of zest after purposes, of joy and grief, of interest concentrated on self, of interest directed beyond self, of short-time and long-time failures or successes, of different layers of feeling, of life-weariness and of life-zest.

There is a quality of life which lies always beyond the mere fact of life; and when we include the quality in the fact, there is still omitted the quality of the quality. It is not true that the finer quality is the direct associate of obvious happiness or obvious pleasure. Religion is the direct apprehension that, beyond such happiness and such pleasure, there remains the function of what is actual and passing, that it contributes its quality as an immortal fact to the order which informs the world.

CHAPTER III *BODY AND SPIRIT*

I. RELIGION AND METAPHYSICS

Religion requires a metaphysical backing; for its authority is endangered by the intensity of the emotions which it generates. Such emotions are evidence of some vivid experience; but they are a very poor guarantee for its correct interpretation.

Thus dispassionate criticism of religious belief is beyond all things necessary. The foundations of dogma must be laid in a rational metaphysics which criticises meanings, and endeavours to express the most general concepts adequate for the all-inclusive universe.

This position has never been seriously doubted, though in practice it is often evaded. One of the most serious periods of neglect

occurred in the middle of the nineteenth century, through the dominance of the historical interest.

It is a curious delusion that the rock upon which our beliefs can be founded is an historical investigation. You can only interpret the past in terms of the present. The present is all that you have; and unless in this present you can find general principles which interpret the present as including a representation of the whole community of existents, you cannot move a step beyond your little patch of immediacy.

Thus history presupposes a metaphysic. It can be objected that we believe in the past and talk about it without settling our metaphysical principles. That is certainly the case. But you can only deduce metaphysical dogmas from your interpretation of the past on the basis of a prior metaphysical interpretation of the present.*

In so far as your metaphysical beliefs are implicit, you vaguely interpret the past on the lines of the present. But when it comes to the primary metaphysical data, the world of which you are immediately conscious is the whole datum.

This criticism applies equally to a science or to a religion which hopes to justify itself without any appeal to metaphysics. The difference is that religion is the longing of the spirit that the facts of existence should find their justification in the nature of existence. 'My soul thirsteth for God,' writes the Psalmist.

But science can leave its metaphysics implicit and retire behind our belief in the pragmatic value of its general descriptions. If religion does that, it admits that its dogmas are merely pleasing ideas for the purpose of stimulating its emotions. Science (at least as a temporary methodological device) can rest upon a naïve faith; religion is the longing for justification. When religion ceases to seek for penetration, for clarity, it is sinking back into its lower forms. The ages of faith are the ages of rationalism.

II. THE CONTRIBUTION OF RELIGION TO METAPHYSICS

In the previous lectures religious experience was considered as a fact. It consists of a certain widespread, direct apprehension of a

* By 'metaphysics' I mean the science which seeks to discover the general ideas which are indispensably relevant to the analysis of everything that happens.

character exemplified in the actual universe. Such a character includes in itself certain metaphysical presuppositions. In so far as we trust the objectivity of the religious intuitions, to that extent we must also hold that the metaphysical doctrines are well founded.

It is for this reason that in the previous lecture the broadest view of religious experience was insisted on. If, at this stage of thought, we include points of radical divergence between the main streams, the whole evidential force is indefinitely weakened. Thus religious experience cannot be taken as contributing to metaphysics any direct evidence for a personal God in any sense transcendent or creative.

The universe, thus disclosed, is through and through interdependent. The body pollutes the mind, the mind pollutes the body. Physical energy sublimates itself into zeal; conversely, zeal stimulates the body. The biological ends pass into ideals of standards, and the formation of standards affects the biological facts. The individual is formative of the society, the society is formative of the individual. Particular evils infect the whole world, particular goods point the way of escape.

The world is at once a passing shadow and a final fact. The shadow is passing into the fact, so as to be constitutive of it; and yet the fact is prior to the shadow. There is a kingdom of heaven prior to the actual passage of actual things, and there is the same kingdom finding its completion through the accomplishment of this passage.

But just as the kingdom of heaven transcends the natural world, so does this world transcend the kingdom of heaven. For the world is evil, and the kingdom is good. The kingdom is in the world, and yet not of the world.

The actual world, the world of experiencing, and of thinking, and of physical activity, is a community of many diverse entities; and these entities contribute to, or derogate from, the common value of the total community. At the same time, these actual entities are, for themselves, their own value, individual and separable. They add to the common stock and yet they suffer alone. The world is a scene of solitariness in community.

The individuality of entities is just as important as their community. The topic of religion is individuality in community.

III. A METAPHYSICAL DESCRIPTION

A metaphysics is a description. Its discussion so as to elucidate its accuracy is necessary, but it is foreign to the description. The tests of accuracy are logical coherence, adequacy, and exemplification. A metaphysical description takes its origin from one select field of interest. It receives its confirmation by establishing itself as adequate and as exemplified in other fields of interest.* The following description is set out for immediate comparison with the deliverances of religious experience.

There are many ways of analyzing the universe, conceived as that which is comprehensive of all that there is. In a description it is thus necessary to correlate these different routes of analysis. First, consider the analysis into (1) the actual world, passing in time; and (2) those elements which go to its formation.

Such formative elements are not themselves actual and passing; they are the factors which are either non-actual or non-temporal, disclosed in the analysis of what is both actual and temporal.

They constitute the formative character of the actual temporal world. We know nothing beyond this temporal world and the formative elements which jointly constitute its character. The temporal world and its formative elements constitute for us the all-inclusive universe.

These formative elements are:

1. The creativity whereby the actual world has its character of temporal passage to novelty.
2. The realm of ideal entities, or forms, which are in themselves not actual, but are such that they are exemplified in everything that is actual, according to some proportion of relevance.
3. The actual but non-temporal entity whereby the indetermination of mere creativity is transmuted into a determinate freedom. This non-temporal actual entity is what men call God—the supreme God of rationalized religion.

A further elucidation of the status of these formative elements is only to be obtained by having recourse to another mode of analysis of the actual world.

* For the application to science of this description, cf. my *Science and the Modern World.*

The actual temporal world can be analyzed into a multiplicity of occasions of actualization. These are the primary actual units of which the temporal world is composed. Call each such occasion an 'epochal occasion.' Then the actual world is a community of epochal occasions. In the physical world each epochal occasion is a definite limited physical event, limited both as to space and time, but with time-duration as well as with its full spatial dimensions.

The epochal occasions are the primary units of the actual community, and the community is composed of the units. But each unit has in its nature a reference to every other member of the community, so that each unit is a microcosm representing in itself the entire all-inclusive universe.

These epochal occasions are the creatures. The reason for the temporal character of the actual world can now be given by reference to the creativity and the creatures. For the creativity is not separable from its creatures. Thus the creatures remain with the creativity. Accordingly, the creativity for a creature becomes the creativity with the creature, and thereby passes into another phase of itself. It is now the creativity for a new creature. Thus there is a transition of the creative action, and this transition exhibits itself, in the physical world, in the guise of routes of temporal succession.

This protean character of the creativity forbids us from conceiving it as an actual entity. For its character lacks determinateness. It equally prevents us from considering the temporal world as a definite actual creature. For the temporal world is an essential incompleteness. It has not the character of a definite matter of fact, such as attaches to an event in past history, viewed from a present standpoint.

An epochal occasion is a concretion. It is a mode in which diverse elements come together into a real unity. Apart from that concretion, these elements stand in mutual isolation. Thus an actual entity is the outcome of a creative synthesis, individual and passing.

The various elements which are thus brought into unity are the other creatures and the ideal forms and God. These elements are not a mere unqualified aggregate. In such a case there could only be one creature. In the concretion the creatures are qualified by the ideal forms, and conversely, the ideal forms are qualified by the creatures. Thus the epochal occasion, which is thus emergent, has in its own nature the other creatures under the aspect of these forms, and analogously it includes the forms under the aspect of these

creatures. It is thus a definite limited creature, emergent in consequence of the limitations thus mutually imposed on each other by the elements.

IV. GOD AND THE MORAL ORDER

The inclusion of God in every creature shows itself in the determination whereby a definite result is emergent. God is that non-temporal actuality which has to be taken account of in every creative phase. Any such phase is determinate having regard to its antecedents, and in this determination exhibits conformity to a common order.

The boundless wealth of possibility in the realm of abstract form would leave each creative phase still indeterminate, unable to synthesize under determinate conditions the creatures from which it springs. The definite determination which imposes ordered balance on the world requires an actual entity imposing its own unchanged consistency of character on every phase.

Thus creative indetermination attains its measure of determination. A simpler metaphysic would result if we could stop at this conclusion. A complete determinism would thus mean the complete self-consistency of the temporal world. This is the conclusion of all thinkers who are inclined to trust to the adequacy of metaphysical concepts.

The difficulty of this conclusion comes when we confront the theory with the facts of the world. If the theory of complete determinism, by reason of the necessity of conformation with the nature of God, holds true, then the evil in the world is in conformity with the nature of God.

Now evil is exhibited in physical suffering, mental suffering, and loss of the higher experience in favour of the lower experience. The common character of all evil is that its realization in fact involves that there is some concurrent realization of a purpose towards elimination. The purpose is to secure the avoidance of evil. The fact of the instability of evil is the moral order in the world.

Evil, triumphant in its enjoyment, is so far good in itself; but beyond itself it is evil in its character of a destructive agent among things greater than itself. In the summation of the more complete fact it has secured a descent towards nothingness, in contrast to the creativeness of what can without qualification be termed

good. Evil is positive and destructive; what is good is positive and creative.

This instability of evil does not necessarily lead to progress. On the contrary, the evil in itself leads to the world losing forms of attainment in which that evil manifests itself. Either the species ceases to exist, or it sinks back into a stage in which it ranks below the possibility of that form of evil. For example, a species whose members are always in pain will either cease to exist, or lose the delicacy of perception which results in that pain, or develop a finer and more subtle relationship among its bodily parts.

Thus evil promotes its own elimination by destruction, or degradation, or by elevation. But in its own nature it is unstable. It must be noted that the state of degradation to which evil leads, when accomplished, is not in itself evil, except by comparison with what might have been. A hog is not an evil beast, but when a man is degraded to the level of a hog, with the accompanying atrophy of finer elements, he is no more evil than a hog. The evil of the final degradation lies in the comparison of what is with what might have been. During the process of degradation the comparison is an evil for the man himself, and at its final stage it remains an evil for others.

But in this last point respecting the evil for others, it becomes plain that, with a sufficiently comprehensive view, a stable state of final degradation is not reached. For the relationships with society and the indirect effects have to be taken into account. Also destruction when accomplished is not an evil for the thing destroyed. For there is no such thing. Again the evil lies in the loss to the social environment. There is evil when things are at cross purposes.

The contrast in the world between evil and good is the contrast between the turbulence of evil and the "peace which passeth all understanding." There is a self-preservation inherent in that which is good in itself. Its destruction may come from without but not from within. Good people of narrow sympathies are apt to be unfeeling and unprogressive, enjoying their egotistical goodness. Their case, on a higher level, is analogous to that of the man completely degraded to a hog. They have reached a state of stable goodness, so far as their own interior life is concerned. This type of moral correctitude is, on a larger view, so like evil that the distinction is trivial.

Thus if God be an actual entity which enters into every creative phase and yet is above change, He must be exempt from internal in-

consistency which is the note of evil. Since God is actual, He must include in himself a synthesis of the total universe. There is, therefore, in God's nature the aspect of the realm of forms as qualified by the world, and the aspect of the world as qualified by the forms. His completion, so that He is exempt from transition into something else, must mean that his nature remains self-consistent in relation to all change.

Thus God is the measure of the aesthetic consistency of the world. There is some consistency in creative action, because it is conditioned by his immanence.

If we trace the evil in the world to the determinism derived from God, then the inconsistency in the world is derived from the consistency of God. Also the incompletion in the world is derivative from the completion of God.

The temporal world exhibits two sides of itself. On one side it exhibits an order in matter of fact, and a self-contrast with ideals, which show that its creative passage is subject to the immanence of an unchanging actual entity. On the other side its incompletion, and its evil, show that the temporal world is to be construed in terms of additional formative elements which are not definable in the terms which are applicable to God.

V. VALUE AND THE PURPOSE OF GOD

The purpose of God is the attainment of value in the temporal world. An active purpose is the adjustment of the present for the sake of adjustment of value in the future, immediately or remotely.

Value is inherent in actuality itself. To be an actual entity is to have a self-interest. This self-interest is a feeling of self-valuation; it is an emotional tone. The value of other things, not one's self, is the derivative value of being elements contributing to this ultimate self-interest. This self-interest is the interest of what one's existence, as in that epochal occasion, comes to. It is the ultimate enjoyment of being actual.

But the actuality is the enjoyment, and this enjoyment is the experiencing of value. For an epochal occasion is a microcosm inclusive of the whole universe. This unification of the universe, whereby its various elements are combined into aspects of each other, is an atomic unit within the real world.

Such an ultimate concrete fact is of the nature of an act of per-

ceptivity. But, if we are speaking of the non-mental facts, such perceptivity is blind. It is without reflective consciousness; it is the self-value of its own microcosmic apprehension. The self-value is the unit fact which emerges. In calling it a perceptivity, or an apprehension, we are already analyzing it into the separate ingredients which go to form the one emergent thing. Each actual entity is an arrangement of the whole universe, actual and ideal, whereby there is constituted that self-value which is the entity itself.

Thus the epochal occasion has two sides. On one side it is a mode of creativity bringing together the universe. This side is the occasion as the cause of itself, its own creative act. We are here conceiving the creation as the reverse of our analysis. For in our description we are holding the elements apart; whereas in the creation they are put together.

On the other side, the occasion is the creature. This creature is that one emergent fact. This fact is the self-value of the creative act. But there are not two actual entities, the creativity and the creature. There is only one entity which is the self-creating creature.

The description of the variety of aspects, under which the various actual occasions enter into each other's natures, is the description of the various relationships within the real physical and spiritual worlds.

The mental occasion is derivative from its physical counterpart. It is also equally of the character of a perceptivity issuing into value-feeling, but it is a reflective perceptivity.

There are two routes of creative passage from a physical occasion. One is towards another physical occasion, and the other is towards the derivative reflective occasion. The physical route links together physical occasions as successive temporal incidents in the life of a body. The other route links this bodily life with a correlative mental life. A mental occasion is an ultimate fact in the spiritual world, just as a physical occasion of blind perceptivity is an ultimate fact in the physical world. There is an essential reference from one world to the other.

There is no such thing as bare value. There is always a specific value, which is the created unit of feeling arising out of the specific mode of concretion of the diverse elements. These different specific value-feelings are comparable amid their differences; and the ground for this comparability is what is here termed 'value.'

This comparability grades the various occasions in respect to the

intensiveness of value. The zero of intensiveness means the collapse of actuality. All intensive quantity is merely the contribution of some one element in the synthesis to this one intensiveness of value.

Various occasions are thus comparable in respect to their relative depths of actuality. Occasions differ in importance of actuality. Thus the purpose of God in the attainment of value is in a sense a creative purpose. Apart from God, the remaining formative elements would fail in their functions. There would be no creatures, since, apart from harmonious order, the perceptive fusion would be a confusion neutralizing achieved feeling. Here 'feeling' is used as a synonym for 'actuality.'

The adjustment is the reason for the world. It is not the case that there is an actual world which accidentally happens to exhibit an order of nature. There is an actual world because there is an order in nature. If there were no order, there would be no world. Also since there is a world, we know that there is an order. The ordering entity is a necessary element in the metaphysical situation presented by the actual world.

This line of thought extends Kant's argument. He saw the necessity for God in the moral order. But with his metaphysics he rejected the argument from the cosmos. The metaphysical doctrine, here expounded, finds the foundations of the world in the æsthetic experience, rather than—as with Kant—in the cognitive and conceptive experience. All order is therefore æsthetic order, and the moral order is merely certain aspects of æsthetic order. The actual world is the outcome of the æsthetic order, and the æsthetic order is derived from the immanence of God.

VI. BODY AND MIND

Descartes grounded his philosophy on an entirely different metaphysical description of the actual world. He started with cogitating minds, and with extended bodies which are the organic and inorganic bits of matter.

Now in some sense no one doubts but that there are bodies and minds. The only point at issue is the status of such bodies and minds in the scheme of things. Descartes affirmed that they were individual substances, so that each bit of matter is a substance, and each mind is a substance. He also states what he means by a substance. He says:

> And when we conceive of substance, we merely conceive an existent thing which requires nothing but itself in order to exist. To speak truth, nothing but God answers to this description as being that which is absolutely self-sustaining, for we perceive that there is no other created thing which can exist without being sustained by his power. . . .
>
> Created substances, however, whether corporeal or thinking, may be conceived under this common concept; for they are things which need only the concurrence of God in order to exist. . . . When we perceive any attribute, we therefore conclude that some existing thing or substance to which it may be attributed, is necessarily present.*

These sentences are a summary of the presupposition of scientific thought in recent centuries: that the world is composed of bits of stuff with attributes. There are insuperable difficulties in Descartes' view which have led to attempts at simplification, keeping his general supposition of stuff with attributes.

Note that Descartes presupposes three types of substance—namely, God, bits of matter, minds. Descartes' proof of the existence of God is accepted by very few philosophers, religious or otherwise. Indeed, given his starting point, it is difficult to see how any proof can be found.

The simplifications all concern dropping either one or two of these types of substances. For example, dropping God, and retaining only matter and mind; or dropping God and minds, and retaining the matter, as with Hobbes; or dropping matter, and retaining God and minds, as with Berkeley; or dropping matter and minds, and retaining God alone. In this latter case, the temporal world becomes an appearance forming an attribute of God.

But the main point of all such philosophies is that they presuppose individual substance, either one or many individual substances, 'which requires nothing but itself in order to exist.' This presupposition is exactly what is denied in the more Platonic description which has been given in this lecture. There is no entity, not even God, 'which requires nothing but itself in order to exist.'

According to the doctrine of this lecture, every entity is in its essence social and requires the society in order to exist. In fact, the society for each entity, actual or ideal, is the all inclusive universe, including its ideal forms.

But Descartes has the great merit that he states facts which any

* *Principles of Philosophy,* LI and LII. Transl. by Haldane and Ross.

philosophy must fit into its scheme. There are bits of matter, and there are minds. Both matter and mind have to be fitted into the metaphysical scheme.

Now, according to the doctrine of this lecture, the most individual actual entity is a definite act of perceptivity. So matter and mind, which persist through a route of such occasions, must be relatively abstract; and they must gain their specific individualities from their respective routes. The character of a bit of matter must be something common to each occasion of its route; and analogously, the character of a mind must be something common to each occasion of its route. Each bit of matter, and each mind, is a subordinate community—in that sense analogous to the actual world.

But each occasion, in its character of being a finished creature, is a value of some definite specific sort. Thus a mind must be a route whose various occasions exhibit some community of type of value. Similarly a bit of matter—or an electron—must be a route whose various occasions exhibit some community of type of value.

Again in such a route—material or mental—the environment will also partially determine the forms of the occasions. But that which the occasions have in common, so as to form a route of mind or a route of matter, must be derived by inheritance from the antecedent members of the route. The environment may favour this inheritance or may obstruct it. But such influence must be in the background so that there is a real transmission of the common element along the route.

In the case of men and animals, there are obviously routes of mind and routes of matter in the very closest connection, which we will consider more particularly in a moment. In the case of a bit of inorganic matter, any associate route of mentality seems to be negligible.

A belief in purely spiritual beings means, on this metaphysical theory, that there are routes of mentality in respect to which associate material routes are negligible, or entirely absent. At the present moment the orthodox belief is that for all men after death there are such routes, and that for all animals after death there are no such routes.

Also at present it is generally held that a purely spiritual being is necessarily immortal. The doctrine here developed gives no warrant for such a belief. It is entirely neutral on the question of immortality,

or on the existence of purely spiritual beings other than God. There is no reason why such a question should not be decided on more special evidence, religious or otherwise, provided that it is trustworthy. In this lecture we are merely considering evidence with a certain breadth of extension throughout mankind. Until that evidence has yielded its systematic theory, special evidence is indefinitely weakened in its effect.

VII. THE CREATIVE PROCESS

This account of what is meant by the enduring existence of matter and of mind explains such endurance as exemplifying the order immanent in the world. The solid earth survives because there is an order laid upon the creativity in virtue of which second after second, minute after minute, hour after hour, day after day, year after year, century after century, age after age, the creative energy finds in the maintenance of that complex form a centre of experienced perceptivity focusing the universe into one unity.

It survives because the universe is a process of attaining instances of definite experience out of its own elements. Each such instance embraces the whole, omitting nothing, whether it be ideal form or actual fact. But it brings them into its own unity of feeling under gradations of relevance and of irrelevance, and thereby by this limitation issues into that definite experience which it is.

Accordingly, any given instance of experience is only possible so far as the antecedent facts permit. For they are required in order to constitute it. The maintenance, throughout ages of life history, of a given type of experience, in instance after instance of its separate occasions, requires, therefore, the stable order of the actual world.

The creative process is thus to be discerned in that transition by which one occasion, already actual, enters into the birth of another instance of experienced value. There is not one simple line of transition from occasion to occasion, though there may be a dominant line. The whole world conspires to produce a new creation. It presents to the creative process its opportunities and its limitations.

The limitations are the opportunities. The essence of depth of actuality—that is of vivid experience—is definiteness. Now to be definite always means that all the elements of a complex whole contribute to some one effect, to the exclusion of others. The creative process is a process of exclusion to the same extent as it is a process

of inclusion. In this connection 'to exclude' means to relegate to irrelevance in the aesthetic unity, and 'to include' means to elicit relevance to that unity.

The birth of a new instance is the passage into novelty. Consider how any one actual fact, which I will call the ground, can enter into the creative process. The novelty which enters into the derivate instance is the information of the actual world with a new set of ideal forms. In the most literal sense the lapse of time is the renovation of the world with ideas. A great philosopher * has said that time is the mind of space. In respect to one particular new birth of one centre of experience, this novelty of ideal forms will be called the 'consequent.' Thus we are now considering the particular relevance of the consequent to the particular ground supplied by one antecedent occasion.

The derivate includes the fusion of the particular ground with the consequent, so far as the consequent is graded by its relevance to that ground.

In this fusion of ground with consequent, the creative process brings together something which is actual and something which, at its entry into that process, is not actual. The process is the achievement of actuality by the ideal consequent, in virtue of its union with the actual ground. In the phrase of Aristotle, the process is the fusion of being with not-being.

The birth of a new aesthetic experience depends on the maintenance of two principles by the creative purpose:

1. The novel consequent must be graded in relevance so as to preserve some identity of character with the ground.
2. The novel consequent must be graded in relevance so as to preserve some contrast with the ground in respect to that same identity of character.

These two principles are derived from the doctrine that an actual fact is a fact of aesthetic experience. All aesthetic experience is feeling arising out of the realization of contrast under identity.

Thus the consequent must agree with the ground in general type so as to preserve definiteness, but it must contrast with it in respect to contrary instances so as to obtain vividness and quality. In the

* Cf. Samuel Alexander, *Space, Time, and Deity* (Macmillan, 1920), Vol. II, p. 43, et passim.

physical world, this principle of contrast under an identity expresses itself in the physical law that vibration enters into the ultimate nature of atomic organisms. Vibration is the recurrence of contrast within identity of type. The whole possibility of measurement in the physical world depends on this principle. To measure is to count vibrations.

Thus physical quantities are aggregates of physical vibrations, and physical vibrations are the expression among the abstractions of physical science of the fundamental principle of aesthetic experience.

Another example of this same principle is to be found in the connection between body and mind. Both mind and body refer to their life-history of separate concrete occasions. So the connection which we seek is to be found in the creative process relating to a physical occasion, in the life of the body, to its corresponding mental occasion in the life of the mind.

The physical occasion enters into the mental occasion, as already actual, and as contributing to its ground. The reversion from its ground, which the consequent of ideal novelty must exhibit, is now of the most fundamental character. The reversion is the undoing of the synthesis exhibited in the ground. Thus the transition from bodily occasion to mental occasion exhibits a new dimension of transition from that exhibited in the transition from bodily occasion to bodily occasion. In the latter transition there is the novelty of contrast within the one concept of synthesis. In the former, the contrast is the contrast of synthesis itself with its opposite, which is analysis.

Thus in the birth of the mental occasion the consequent of ideal novelty enters into reality, and possesses an analytic force over against the synthetic ground. Ideal forms thus synthesized into a mental occasion are termed concepts. Concepts meet blind experience with an analytic force. Their synthesis with physical occasion, as ground, is the perceptive analysis of the blind physical occasion in respect to its degree of relevance to the concepts.

The phrase 'immediate experience' can have either of two meanings, according as it refers to the physical or to the mental occasion. It may mean a complete concretion of physical relationships in the unity of a blind perceptivity. In this sense 'immediate experience' means an ultimate physical fact. But in a secondary, and more usual, sense it means the consciousness of physical experience. Such consciousness is a mental occasion. It has the character of being an analysis of physical experience by synthesis with the concepts involved

in the mentality. Such analysis is incomplete, because it is dependent on the limitations of the concepts. This limitation arises from the grading of the relevance of the concepts in the mental occasion. The most complete concrete fact is dipolar, physical and mental. But, for some specific purpose, the proportion of importance, as shared between the two poles, may vary from negligibility to dominance of either pole.

The value realized in the mental occasion is knowledge-value. This knowledge-value is the issue of the full character of the creativity into the creature world. There is nothing in the creativity which fails to issue into the actual world. Thus the creativity with a purpose issues into the mental creature conscious of an ideal. Also God, as conditioning the creativity with his harmony of apprehension, issues into the mental creature as moral judgment according to a perfection of ideals.

The order of the world is no accident. There is nothing actual which could be actual without some measure of order. The religious insight is the grasp of this truth: That the order of the world, the depth of reality of the world, the value of the world in its whole and in its parts, the beauty of the world, the zest of life, the peace of life, and the mastery of evil, are all bound together—not accidentally, but by reason of this truth: that the universe exhibits a creativity with infinite freedom, and a realm of forms with infinite possibilities; but that this creativity and these forms are together impotent to achieve actuality apart from the completed ideal harmony, which is God.

CHAPTER IV *TRUTH AND CRITICISM*

I. THE DEVELOPMENT OF DOGMA

In human nature there is no such separate function as a special religious sense. In making this assertion, I am agreeing with the following quotation:

> Those who tend to identify religious experience with the activity of some peculiar organ or element of the mental life have recently made much of the subconscious. Here there seems to be a

safe retreat for the hard-pressed advocates of the uniqueness of religious experience.*

Religious truth must be developed from knowledge acquired when our ordinary senses and intellectual operations are at their highest pitch of discipline. To move one step from this position towards the dark recesses of abnormal psychology is to surrender finally any hope of a solid foundation for religious doctrine.

Religion starts from the generalization of final truths first perceived as exemplified in particular instances. These truths are amplified into a coherent system and applied to the interpretation of life. They stand or fall—like other truths—by their success in this interpretation. The peculiar character of religious truth is that it explicitly deals with values. It brings into our consciousness that permanent side of the universe which we can care for. It thereby provides a meaning, in terms of value, for our own existence, a meaning which flows from the nature of things.

It is not true, however, that we observe best when we are entirely devoid of emotion. Unless there is a direction of interest, we do not observe at all. Further, our capacity for observation is limited. Accordingly, when we are observing some things, we are in a bad position for observing other things.

Thus there are certain emotional states which are most favourable for a peculiar concentration on topics of religious interest, just as other states facilitate the apprehension of arithmetical truths. Also, emotional states are related to states of the body. Most people are more likely to make arithmetical slips when they are tired in the evening. But we still believe that arithmetic holds good from sundown to cockcrow.

Again, it is not true that all people are on a level in respect to their perceptive powers. Some people appear to realize continuously, and at a higher level, types of emotional and perceptive experience, which we recognize as corresponding to those periods of our own lives most worthy of confidence for that sort of experience. In so far as what they say interprets our own best moments, it is reasonable to trust to the evidential force of their experience.

These considerations are all commonplaces, but it is necessary to

* Cf. Prof. E. S. Ames, *The Psychology of Religious Experience* (Houghton Mifflin, 1910), p. 291.

keep them clearly in mind when we endeavour to form our philosophy of religious knowledge.

A dogma is the precise enunciation of a general truth, divested so far as possible from particular exemplification. Such precise expression is in the long run a condition for vivid realization, for effectiveness, for apprehension of width of scope, and for survival.

For example, when the Greeks, such as Pythagoras or Euclid, formulated mathematical dogmas, the general truths which the Egyptians had acted upon for more than thirty generations became thereby of greater importance.

It is not the case, however, that our apprehension of a general truth is dependent upon its accurate verbal expression. For it would follow that we could never be dissatisfied with the verbal expression of something that we had never apprehended. But this consciousness of failure to express our accurate meaning must have haunted most of us.

For example, the notion of irrational number had been used in mathematics for over two thousand years before it received accurate definition in the last quarter of the nineteenth century. Also, Newton and Leibniz introduced the differential calculus, which was the foundation of modern mathematical physics. But the mathematical notions involved did not receive adequate verbal expression for two hundred and fifty years.

Such recondite examples are quite unnecessary. We know more of the characters of those who are dear to us than we can express accurately in words. We may recognize the truth of some statement about them. It will be a new statement about something which we had already apprehended but had never formulated.

This example brings out another fact: that a one-sided formulation may be true, but may have the effect of a lie by its distortion of emphasis. Such distortion does not stand in its character of a truth, but depends upon those who are affected by it. So far as the make-up of an individual mind is concerned, there is a proportion in truth as well as in art.

Thus an ill-balanced zeal for the propagation of dogma bears witness to a certain coarseness of aesthetic sensitiveness. It shows a strain of indifference—due perhaps to arrogance, perhaps to rashness, perhaps to mere ignorance—a strain of indifference to the fact that others may require a proportion of formulation different from that

suitable for ourselves. Perhaps our pet dogmas require correction: they may even be wrong.

The fate of a word has to the historian the value of a document. The modern unfavourable implications of the kindred words, dogma, dogmatic, dogmatist, tell the story of some failure in habits of thought. The word 'dogma' originally means an 'opinion,' and thence more especially a 'philosophic opinion.' Thus, for example, the Greek physician, Galen, uses the phrase 'dogmatic physicians' to mean 'physicians who guide themselves by general principles'—surely a praiseworthy practice. The nearest Greek dictionary will give this elementary information. But the dictionary—and this is why I have quoted it—gives an ominous addition to the information about Galen. It says that Galen contrasts 'dogmatic physicians' with 'empiric physicians.' If you then refer to the word 'empiric,' you will find that 'empiric physicians' contended that 'experience was the one thing needful.' In this lecture we have to investigate the application to religion of this contrast between 'dogmatic' and 'empiric.'

The philosophy of expression is only now receiving its proper attention.* In the framing of dogmas it is only possible to use ideas which have received a distinct, well-recognized signification. Also no idea is determinate in a vacuum: It has its being as one of a system of ideas. A dogma is the expression of a fact as it appears within a certain sphere of thought. You cannot convey a dogma by merely translating the words; you must also understand the system of thought to which it is relevant. To take a very obvious example, 'The Fatherhood of God' is a phrase which would have a significance for a Roman citizen of the early Republic different from that which it has for a modern American—stern for the one, tender for the other.

In estimating the validity of a dogma, it must be projected against the alternatives to it within that sphere of thought. You cannot claim absolute finality for a dogma without claiming a commensurate finality for the sphere of thought within which it arose. If the dogmas of the Christian Church from the second to the sixth centuries express finally and sufficiently the truths concerning the topics about which they deal, then the Greek philosophy of that period had developed a system of ideas of equal finality. You cannot limit the inspiration to a narrow circle of creeds.

* Cf. *Symbolism and Truth,* by R. M. Eaton (Harvard University Press, 1925).

A dogma—in the sense of a precise statement—can never be final; it can only be adequate in its adjustment of certain abstract concepts. But the estimate of the status of these concepts remains for determination.

You cannot rise above the adequacy of the terms you employ. A dogma may be true in the sense that it expresses such interrelations of the subject matter as are expressible within the set of ideas employed. But if the same dogma be used intolerantly so as to check the employment of other modes of analyzing the subject matter, then, for all its truth, it will be doing the work of a falsehood.

Progress in truth—truth of science and truth of religion—is mainly a progress in the framing of concepts, in discarding artificial abstractions or partial metaphors, and in evolving notions which strike more deeply into the root of reality.

II. EXPERIENCE AND EXPRESSION

Expression is the one fundamental sacrament. It is the outward and visible sign of an inward and spiritual grace. It follows that, in the process of forming a common expression of direct intuition, there is first a stage of primary expression into some medium of sense-experience which each individual contributes at first hand. No one can do this for another. It is the contribution of each to the knowledge of all.

This primary expression mainly clothes itself in the media of action and of words, but also partly of art. Their expressiveness to others arises from the fact that they are interpretable in terms of the intuitions of the recipients. Apart from such interpretation, the modes of expression remain accidental, unrationalized happenings of mere sense-experience; but with such interpretation, the recipient extends his apprehension of the ordered universe by penetrating into the inward nature of the originator of the expression. There is then a community of intuition by reason of the sacrament of expression proffered by one and received by the other.

But the expressive sign is more than interpretable. It is creative. It elicits the intuition which interprets it. It cannot elicit what is not there. A note on a tuning fork can elicit a response from a piano. But the piano has already in it the string tuned to the same note. In the same way the expressive sign elicits the existent intuition which would not otherwise emerge into individual distinctiveness. Again in theo-

logical language, the sign works ex opere operato, but only within the limitation that the recipient be patient of the creative action.

There is very little really first-hand expression in the world. By this I mean that most expression is what may be termed responsive expression, namely, expression which expresses intuitions elicited by the expressions of others. This is as it should be; since in this way what is permanent, important, and widely spread, receives more and more a clear definition.

But there is need for something more than this responsive expression. For it is not true that there is easy apprehension of the great formative generalities. They are embedded under the rubbish of irrelevant detail. Men knew a lot about dogs before they thought of backbones and of vertebrates. The great intuitions, which in their respective provinces set all things right, dawn but slowly upon history.

With this prevalence of responsive expression, we are used to a learned literature and to imitative conduct. When we get anything which is neither learned nor imitative, it is often very evil. But sometimes it is genius.

The history of culture shows that originality of expression is not a process of continuous development. There are antecedent periods of slow evolution. Finally, as if touched by a spark, a very few persons, one, two, or three, in some particular province of experience, express completely novel intuitions. Such intuitions can be responded to, analyzed in terms of their relationships to other ideas, fused with other forms of experience, but as individual primary intuitions within their own province of experience they are not surpassed.

The world will not repeat Dante, Shakespeare, Socrates, or the Greek tragedians. These men, in connection with the tiny groups forming their immediate environments of associates and successors and perhaps of equals, add something once and for all. We develop in connection with them, but not beyond them, in respect to those definite intuitions which they flashed upon the world. These examples are taken from the circle of literature merely for the sake of easy intelligibility.

There are two points to be noticed about them. In the first place, they are associated with a small stage fitted for their peculiar originality. Standardized size can do almost anything, except foster the growth of genius. That is the privilege of the tiny oasis. Goethe surveyed the world, but it was from Weimar; Shakespeare is universal,

but he lived in Elizabethan England. We cannot think of Socrates outside Athens.

The second characteristic is that their peculiar originality is the very element in their expression which remains unformularized. They deal with what all men know, and they make it new. They do not bring to the world a new formula nor do they discover new facts, but in expressing their apprehensions of the world, they leave behind them an element of novelty—a new expression forever evoking its proper response.

Some original men do express themselves in formulae: but the formula then expresses something beyond itself. The formula is then secondary to its meaning; it is, in a sense, a literary device. The formula sinks in importance, or even is abandoned; but its meaning remains fructifying in the world, finding new expression to suit new circumstances. The formula was not wrong, but it was limited to its own sphere of thought.

In particular, the view that there are a few fundamental dogmas is arbitrary. Every true dogma which formulates with some adequacy the facts of a complex religious experience is fundamental for the individual in question and he disregards it at his peril. For formulation increases vividness of apprehension, and the peril is the loss of an aid in the difficult task of spiritual ascent.

But every individual suffers from invincible ignorance; and a dogma which fails to evoke any response in immediate apprehension stifles the religious life. There is no mechanical rule and no escape from the necessity of complete sincerity either way.

Thus religion is primarily individual, and the dogmas of religion are clarifying modes of external expression. The intolerant use of religious dogmas has practically destroyed their utility for a great, if not the greater, part of the civilized world.

Expression, and in particular expression by dogma, is the return from solitariness to society. There is no such thing as absolute solitariness. Each entity requires its environment. Thus man cannot seclude himself from society.

Even for individual intuitions outward expression is necessary, as a sacrament in which the minister and recipient are one. But further, what is known in secret must be enjoyed in common, and must be verified in common. The immediate conviction of the moment in this

way justifies itself as a rational principle enlightening the objective world.

The great instantaneous conviction in this way becomes the Gospel, the good news. It insists on its universality, because it is either that or a passing fancy. The conversion of the Gentiles is both the effect of truth and the test of truth.

Thus the simplicity of inspiration has passed from its first expression into responsive experience. It then disengages itself from particular experience by formulation in precise dogmas, and so faces the transformations of history.

In this passage a religion coalesces with other factors in human life. It is expanded, explained, modified, adapted. If it was originally founded upon truth, it maintains its identity by its recurrence to the inspired simplicity of its origin. The dogmas are statements of how the complex world is to be expressed in the light of the intuitions fundamental to the religion. They are not necessarily simple in character or limited in number.

III. THE THREE TRADITIONS

The divergence in the expression of dogmas is most clearly shown in the two traditions of Buddhism and Christianity. This divergence is important because it reaches down to the most fundamental religious concepts, namely, the nature of God, and the aim of life.

There are close analogies between the two religions. In both there is, in some sense, a saviour—Christ in the one, and the Buddha in the other. But their functions differ, according to the theologies of the two religions. In both, the souls of the blessed return to God. Again, this analogy cloaks a wide divergence; for the respective concepts of God, and the respective concepts of the meaning of the return of the soul, differ in both cases.

The moral codes have striking analogies. But again there are divergencies which flow naturally from the theological differences. To put it briefly, Buddhism, on the whole, discourages the sense of active personality, whereas Christianity encourages it. For example, modern European philosophy, which had its origin in Plato and Aristotle, after sixteen hundred years of Christianity reformulated its problems with increased attention to the importance of the individual subject of experience, conceived as an abiding entity with a transition of

experiences. If Europe, after the Greek period, had been subject to the Buddhist religion, the change of philosophical climate would have been in the other direction.

This reformation of philosophy has emphasized the divergence. For the abiding individual substance, mind or matter, is now conceived as the subject supporting the transition of experiences. Thus, according to prevalent Western notions, the moral aims of Buddhism are directed to altering the first principles of metaphysics.

The absolute idealism, so influential in Europe and America during the last third of the nineteenth century, and still powerful notwithstanding the reaction from it, was undoubtedly a reaction towards Buddhistic metaphysics on the part of the Western mentality. The multiplicity of finite enduring individuals was relegated to a world of appearances, and the ultimate reality was centred in an Absolute.

But meanwhile science had appeared as a third organized system of thought which in many respects played the part of a theology, by reason of the answers which it gave to current theological questions. Science suggested a cosmology; and whatever suggests a cosmology, suggests a religion.

From its very beginning in the sixteenth and seventeenth centuries, science emphasized ideas which modified the religious picture of the world. As the medieval picture dissolved, religion and philosophy equally received shock after shock, with a final culmination in the middle of the nineteenth century.

Philosophy, by its nature, was less wedded to its aboriginal picture of the world than was religion. Accordingly it divided itself into two streams of thought. One stream subordinated itself entirely to science, and has asserted its mission to be the discussion of the proper coördination of notions employed in current scientific practice. The other stream, which is that of absolute idealism, sidetracked science by proclaiming that science dealt with finite truths respecting a world of appearances; and that these appearances were not very real, and that these truths were not very true. It reserved for philosophy the determination of all that was to be known concerning the ultimate reality, and concerning our own participation in that final absolute fact.

The importance of rational religion in the history of modern culture is that it stands or falls with its fundamental position, that we

know more than can be formulated in one finite systematized scheme of abstractions, however important that scheme may be in the elucidation of some aspect of the order of things.

The final principle of religion is that there is a wisdom in the nature of things, from which flow our direction of practice, and our possibility of the theoretical analysis of fact. It grounds this principle upon two sources of evidence, first upon our success in various special theoretical sciences, physical and otherwise; and secondly, upon our knowledge of a discernment of ordered relationships, especially in aesthetic valuations, which stretches far beyond anything which has been expressed systematically in words.

According to religion, this discernment of relationships forms in itself the very substance of existence. The formulations are the froth upon the surface. Religion insists that the world is a mutually adjusted disposition of things, issuing in value for its own sake. This is the very point that science is always forgetting.

Religions commit suicide when they find their inspirations in their dogmas. The inspiration of religion lies in the history of religion. By this I mean that it is to be found in the primary expressions of the intuitions of the finest types of religious lives. The sources of religious belief are always growing, though some supreme expressions may lie in the past. Records of these sources are not formulae. They elicit in us intuitive response which pierces beyond dogma.

But dogmatic expression is necessary. For whatever has objective validity is capable of partial expression in terms of abstract concepts, so that a coherent doctrine arises which elucidates the world beyond the locus of the origin of the dogmas in question.

Also exact statements are the media by which identical intuitions into the world can be identified amid a wide variety of circumstances.

But the dogmas, however true, are only bits of the truth, expressed in terms which in some ways are over-assertive and in other ways lose the essence of truth. When exactly understood in relation to an exact system of philosophic thought, they may—or may not—be exactly true.

But in respect to this exact truth, they are very abstract—much more abstract than the representations of them in popular thought. Also in fact, there never has been any exact, complete system of philosophic thought, and there never has been any exact understand-

ing of dogmas, an understanding which has been properly confined to strict interpretation in terms of a philosophic system, complete or incomplete.

Accordingly, though dogmas have their measure of truth, which is unalterable, in their precise forms they are narrow, limitative, and alterable: in effect untrue, when carried over beyond the proper scope of their utility.

A system of dogmas may be the ark within which the Church floats safely down the flood-tide of history. But the Church will perish unless it opens its window and lets out the dove to search for an olive branch. Sometimes even it will do well to disembark on Mount Ararat and build a new altar to the divine Spirit—an altar neither in Mount Gerizim nor yet at Jerusalem.

The decay of Christianity and Buddhism, as determinative influences in modern thought, is partly due to the fact that each religion has unduly sheltered itself from the other. The self-sufficient pedantry of learning and the confidence of ignorant zealots have combined to shut up each religion in its own forms of thought. Instead of looking to each other for deeper meanings, they have remained self-satisfied and unfertilized.

Both have suffered from the rise of the third tradition, which is science, because neither of them had retained the requisite flexibility of adaptation. Thus the real, practical problems of religion have never been adequately studied in the only way in which such problems can be studied, namely, in the school of experience.

One most obvious problem is how to save the intermediate imaginative representations of spiritual truths from loss of effectiveness, if the possibility of modifications of dogma are admitted. The religious spirit is not identical with dialectical acuteness. Thus these intermediate representations play a great part in religious life. They are enshrined in modes of worship, in popular religious literature, and in art. Religions cannot do without them; but if they are allowed to dominate, uncriticized by dogma or by recurrence to the primary sources of religious inspiration, they are properly to be termed idols. In Christian history, the charge of idolatry has been bandied to and fro among rival theologians. Probably, if taken in its wide sense, it rests with equal truth on all the main churches, Protestant and Catholic. Idolatry is the necessary product of static dogmas.

But the problem of so handling popular forms of thought as to

keep their full reference to the primary sources, and yet also to keep them in touch with the best critical dogmas of their times, is no easy one. The chief figures in the history of the Christian Church who seem to have grasped explicitly its central importance were, Origen in the Church of Alexandria, in the early part of the third century, and Erasmus in the early part of the sixteenth century. Their analogous fates show the wavering attitude of the Christian Church, culminating in lapses into dogmatic idolatry. It must, however, be assigned to the great credit of the Papacy of his time, that Erasmus never in his lifetime lost the support of the court of Rome.* Unfortunately Erasmus, though a good man, was no hero, and the moral atmosphere of the Renaissance Papacy was not equal to its philosophic insight. In the phrase of Leo X, the quarrel of monks began; and yet another golden opportunity was lost, while rival pedants cut out neat little dogmatic systems to serve as the unalterable measure of the Universe.

IV. THE NATURE OF GOD

The general history of religious thought, of which the Reformation period is a particular instance, is that of the endeavour of mankind to interpret the great standard experiences as leading to a more definite knowledge than can be derived from a metaphysic which founds itself upon general experience.

There can be nothing inherently illegitimate in such an attempt. But if we attend to the general principles which regulate all endeavours after clear statement of truth, we must be prepared to amplify, recast, generalize, and adapt, so as to absorb into one system all sources of experience.

The earlier statements will be not so much wrong, as obscured by trivial limitations, and as thereby implying an exclusion of complementary truths. The growth will be in the proportion of truth.

The doctrines—fundamental to religion—of the nature of God must be construed in this sense. It is in respect to this doctrine that the great cleavages of religious thought arise. The extremes are the doctrine of God as the impersonal order of the universe, and the doctrine of God as the one person creating the universe.

A general concept has to be construed in terms of a descriptive metaphysical system. In this concluding section of this course, we ask

* Erasmus received the offer of a Cardinalate in 1534, and died in 1536. His works have since been placed on the Index.

what can be said of the nature of God in terms of the metaphysical description which has been adopted as the basis of thought in this course of lectures, and which was more particularly described in the previous lecture.

To be an actual thing is to be limited. An actual thing is an elicited feeling-value, which is analyzable as the outcome of a graded grasping of the elements of the universe into the unity of one fact. This grasping together may be called a perception. The grading means the grading of relevance of the various elements, so far as concerns their contribution to the one actual fact.

The synthesis is the union of what is already actual with what is, for that occasion, new for realization. I have called it the union of the actual ground with the novel consequent. The ground is formed by all the facts of the world, already actual and graded in their proportion of relevance. The consequent is constituted by all the ideal forms of possibility, graded in their proportion. The grading of the actual ground arises from the creativity of some actual fact passing over into a new form by reason of the fact itself. The new creativity, under consideration, has thus already a definite status in the world, arising from its particular origin. We can indifferently say that the grading arises from the status, or the status from the grading. They are different ways of saying the same thing.

The grading of the ideal forms arises from the grading of the actual facts. It is the union of the forms with the facts in such measure as to elicit a renewed feeling-value, of the type possible as a novel outcome from the antecedent facts.

The grading of the ideal forms arises from the grading of the actual facts. It is the union of the forms with the facts in such measure as to elicit a renewed feeling-value, of the type possible as a novel outcome from the antecedent facts.

Depth of value is only possible if the antecedent facts conspire in unison. Thus a measure of harmony in the ground is requisite for the perpetuation of depth into the future. But harmony is limitation. Thus rightness of limitation is essential for growth of reality.

Unlimited possibility and abstract creativity can procure nothing. The limitation, and the basis arising from what is already actual, are both of them necessary and interconnected.

Thus the whole process itself, viewed at any stage as a definite limited fact which has issued from the creativity, requires a definite

entity, already actual among the formative elements, as an antecedent ground for the entry of the ideal forms into the definite process of the temporal world.

But such a complete aboriginal actuality must differ from actuality in process of realization in respect to the blind occasions of perceptivity which issue from process and require process. These occasions build up the physical world which is essentially in transition.

God, who is the ground antecedent to transition, must include all possibilities of physical value conceptually, thereby holding the ideal forms apart in equal, conceptual realization of knowledge. Thus, as concepts, they are grasped together in the synthesis of omniscience.

The limitation of God is his goodness. He gains his depth of actuality by his harmony of valuation. It is not true that God is in all respects infinite. If He were, He would be evil as well as good. Also this unlimited fusion of evil with good would mean mere nothingness. He is something decided and is thereby limited.

He is complete in the sense that his vision determines every possibility of value. Such a complete vision coordinates and adjusts every detail. Thus his knowledge of the relationships of particular modes of value is not added to, or disturbed, by the realization in the actual world of what is already conceptually realized in his ideal world. This ideal world of conceptual harmonization is merely a description of God himself. Thus the nature of God is the complete conceptual realization of the realm of ideal forms. The kingdom of heaven is God. But these forms are not realized by him in mere bare isolation, but as elements in the value of his conceptual experience. Also, the ideal forms are in God's vision as contributing to his complete experience, by reason of his conceptual realization of their possibilities as elements of value in any creature. Thus God is the one systematic, complete fact, which is the antecedent ground conditioning every creative act.

The depths of his existence lie beyond the vulgarities of praise or of power. He gives to suffering its swift insight into values which can issue from it. He is the ideal companion who transmutes what has been lost into a living fact within his own nature. He is the mirror which discloses to every creature its own greatness.

The kingdom of heaven is not the isolation of good from evil. It is the overcoming of evil by good. This transmutation of evil into good enters into the actual world by reason of the inclusion of the

nature of God, which includes the ideal vision of each actual evil so met with a novel consequent as to issue in the restoration of goodness.

God has in his nature the knowledge of evil, of pain, and of degradation, but it is there as overcome with what is good. Every fact is what it is, a fact of pleasure, of joy, of pain, or of suffering. In its union with God that fact is not a total loss, but on its finer side is an element to be woven immortally into the rhythm of mortal things. Its very evil becomes a stepping-stone in the all-embracing ideals of God.

Every event on its finer side introduces God into the world. Through it his ideal vision is given a base in actual fact to which He provides the ideal consequent, as a factor saving the world from the self-destruction of evil. The power by which God sustains the world is the power of himself as the ideal. He adds himself to the actual ground from which every creative act takes its rise. The world lives by its incarnation of God in itself.

He transcends the temporal world, because He is an actual fact in the nature of things. He is not there as derivative from the world; He is the actual fact from which the other formative elements cannot be torn apart.

But equally it stands in his nature that He is the realization of the ideal conceptual harmony by reason of which there is an actual process in the total universe—an evolving world which is actual because there is order.

The abstract forms are thus the link between God and the actual world. These forms are abstract and not real, because in themselves they represent no achievement of actual value. Actual fact always means fusion into one perceptivity. God is one such conceptual fusion, embracing the concept of all such possibilities graded in harmonious, relative subordination. Each actual occasion in the temporal world is another such fusion. The forms belong no more to God than to any one occasion. Apart from these forms, no rational description can be given either of God or of the actual world. Apart from God, there would be no actual world; and apart from the actual world with its creativity, there would be no rational explanation of the ideal vision which constitutes God.

Each actual occasion gives to the creativity which flows from it a definite character in two ways. In one way, as a fact, enjoying its complex of relationships with the rest of the world, it contributes

a ground—partly good and partly bad—for the creativity to fuse with a novel consequent, which will be the outcome of its free urge. In another way, as transmuted in the nature of God, the ideal consequent as it stands in his vision is also added. Thus God in the world is the perpetual vision of the road which leads to the deeper realities.

V. CONCLUSION

God is that function in the world by reason of which our purposes are directed to ends which in our own consciousness are impartial as to our own interests. He is that element in life in virtue of which judgment stretches beyond facts of existence to values of existence. He is that element in virtue of which our purposes extend beyond values for ourselves to values for others. He is that element in virtue of which the attainment of such a value for others transforms itself into value for ourselves.

He is the binding element in the world. The consciousness which is individual in us, is universal in him: the love which is partial in us is all-embracing in him. Apart from him there could be no world, because there could be no adjustment of individuality. His purpose in the world is quality of attainment. His purpose is always embodied in the particular ideals relevant to the actual state of the world. Thus all attainment is immortal in that it fashions the actual ideals which are God in the world as it is now. Every act leaves the world with a deeper or a fainter impress of God. He then passes into his next relation to the world with enlarged, or diminished, presentation of ideal values.

He is not the world, but the valuation of the world. In abstraction from the course of events, this valuation is a necessary metaphysical function. Apart from it, there could be no definite determination of limitation required for attainment. But in the actual world, He confronts what is actual in it with what is possible for it. Thus He solves all indeterminations.

The passage of time is the journey of the world towards the gathering of new ideas into actual fact. This adventure is upwards and downwards. Whatever ceases to ascend, fails to preserve itself and enters upon its inevitable path of decay. It decays by transmitting its nature to slighter occasions of actuality, by reason of the failure of the new forms to fertilize the perceptive achievements which constitute its past history. The universe shows us two aspects: on one

side it is physically wasting, on the other side it is spiritually ascending.

It is thus passing with a slowness, inconceivable in our measures of time, to new creative conditions, amid which the physical world, as we at present know it, will be represented by a ripple barely to be distinguished from non-entity.

The present type of order in the world has arisen from an unimaginable past, and it will find its grave in an unimaginable future. There remain the inexhaustible realm of abstract forms, and creativity, with its shifting character ever determined afresh by its own creatures, and God, upon whose wisdom all forms of order depend.

Symbolism, Its Meaning and Effect

Chapter I 533

Chapter II 547

SYMBOLISM, ITS MEANING AND EFFECT

In 1927 Whitehead delivered the Barbour-Page Lectures at the University of Virginia, and subsequently published them under the title Symbolism, Its Meaning and Effect. The first two of the three chapters of this book are included here.

In these two chapters Whitehead not only considers the general problem of symbolism, but is primarily concerned with symbolism in relation to the problem of perception, or what has been called "our knowledge of the external world." He develops his theory of the two modes of perception: the mode of presentational immediacy, and the mode of casual efficacy, and their interrelationship. Students of The Concept of Nature will find here a fuller treatment of some of the ideas first introduced in that book, while the whole notion of the interplay of the two modes of perception is dealt with in great detail in Part II of Process and Reality, and Part III of Adventures of Ideas. In fact, it is not too much to say that the whole theory of the relationship between physical prehensions and conceptual prehensions, which is presented in systematic detail in Part III of Process and Reality, rests ultimately upon the kind of evidence introduced in these two chapters.

These chapters present what has been termed Whitehead's "answer to Hume." It is suggested that the reader refer to the distinction between the "homogeneous" and "heterogeneous" ways of interpreting nature, introduced in Chapter I of The Concept of Nature. This distinction is important to the arguments in Symbolism, and makes it clear that Whitehead has not chosen to "answer" Hume entirely on Hume's terms.

CHAPTER I

1. *Kinds of Symbolism*

The slightest survey of different epochs of civilization discloses great differences in their attitude towards symbolism. For example, during the medieval period in Europe symbolism seemed to dominate men's imaginations. Architecture was symbolical, ceremonial was symbolical, heraldry was symbolical. With the Reformation a reaction set in. Men tried to dispense with symbols as 'fond things, vainly invented,' and concentrated on their direct apprehension of the ultimate facts.

But such symbolism is on the fringe of life. It has an unessential element in its constitution. The very fact that it can be acquired in one epoch and discarded in another epoch testifies to its superficial nature.

There are deeper types of symbolism, in a sense artificial, and yet such that we could not get on without them. Language, written or spoken, is such a symbolism. The mere sound of a word, or its shape on paper, is indifferent. The word is a symbol, and its meaning is constituted by the ideas, images, and emotions, which it raises in the mind of the hearer.

There is also another sort of language, purely a written language, which is constituted by the mathematical symbols of the science of algebra. In some ways, these symbols are different to those of ordinary language, because the manipulation of the algebraical symbols does your reasoning for you, provided that you keep to the algebraic rules. This is not the case with ordinary language. You can never forget the meaning of language, and trust to mere syntax to help you out. In any case, language and algebra seem to exemplify more fundamental types of symbolism than do the Cathedrals of Medieval Europe.

2. *Symbolism and Perception*

There is still another symbolism more fundamental than any of the foregoing types. We look up and see a coloured shape in front of us, and we say,—there is a chair. But what we have seen is the mere coloured shape. Perhaps an artist might not have jumped to the

notion of a chair. He might have stopped at the mere contemplation of a beautiful colour and a beautiful shape. But those of us who are not artists are very prone, especially if we are tired, to pass straight from the perception of the coloured shape to the enjoyment of the chair, in some way of use, or of emotion, or of thought. We can easily explain this passage by reference to a train of difficult logical inference, whereby, having regard to our previous experiences of various shapes and various colours, we draw the probable conclusion that we are in the presence of a chair. I am very sceptical as to the high-grade character of the mentality required to get from the coloured shape to the chair. One reason for this scepticism is that my friend the artist, who kept himself to the contemplation of colour, shape and position, was a very highly trained man, and had acquired this facility of ignoring the chair at the cost of great labour. We do not require elaborate training merely in order to refrain from embarking upon intricate trains of inference. Such abstinence is only too easy. Another reason for scepticism is that if we had been accompanied by a puppy dog, in addition to the artist, the dog would have acted immediately on the hypothesis of a chair and would have jumped onto it by way of using it as such. Again, if the dog had refrained from such action, it would have been because it was a well-trained dog. Therefore the transition from a coloured shape to the notion of an object which can be used for all sorts of purposes which have nothing to do with colour, seems to be a very natural one; and we—men and puppy dogs—require careful training if we are to refrain from acting upon it.

Thus coloured shapes seem to be symbols for some other elements in our experience, and when we see the coloured shapes we adjust our actions towards those other elements. This symbolism from our senses to the bodies symbolized is often mistaken. A cunning adjustment of lights and mirrors may completely deceive us; and even when we are not deceived, we only save ourselves by an effort. Symbolism from sense-presentation to physical bodies is the most natural and widespread of all symbolic modes. It is not a mere tropism, or automatic turning towards, because both men and puppies often disregard chairs when they see them. Also a tulip which turns to the light has probably the very minimum of sense-presentation. I shall argue on the assumption that sense-perception is mainly a characteristic of more advanced organisms; whereas all organisms

have experience of causal efficacy whereby their functioning is conditioned by their environment.

3. *On Methodology*

In fact symbolism is very largely concerned with the use of pure sense-perceptions in the character of symbols for more primitive elements in our experience. Accordingly since sense-perceptions, of any importance, are characteristic of high-grade organisms, I shall chiefly confine this study of symbolism to the influence of symbolism on human life. It is a general principle that low-grade characteristics are better studied first in connection with correspondingly low-grade organisms, in which those characteristics are not obscured by more developed types of functioning. Conversely, high-grade characters should be studied first in connection with those organisms in which they first come to full perfection.

Of course, as a second approximation to elicit the full sweep of particular characters, we want to know the embryonic stage of the high-grade character, and the ways in which low-grade characters can be made subservient to higher types of functioning.

The nineteenth century exaggerated the power of the historical method, and assumed as a matter of course that every character should be studied only in its embryonic stage. Thus, for example, 'Love' has been studied among the savages and latterly among the morons.

4. *Fallibility of Symbolism*

There is one great difference between symbolism and direct knowledge. Direct experience is infallible. What you have experienced, you have experienced. But symbolism is very fallible, in the sense that it may induce actions, feelings, emotions, and beliefs about things which are mere notions without that exemplification in the world which the symbolism leads us to presuppose. I shall develop the thesis that symbolism is an essential factor in the way we function as the result of our direct knowledge. Successful high-grade organisms are only possible, on the condition that their symbolic functionings are usually justified so far as important issues are concerned. But the errors of mankind equally spring from symbolism. It is the task of reason to understand and purge the symbols on which humanity depends.

An adequate account of human mentality requires an explanation of (i) how we can know truly, (ii) how we can err, and (iii) how we can critically distinguish truth from error. Such an explanation requires that we distinguish that type of mental functioning which by its nature yields immediate acquaintance with fact, from that type of functioning which is only trustworthy by reason of its satisfaction of certain criteria provided by the first type of functioning.

I shall maintain that the first type of functioning is properly to be called 'Direct Recognition,' and the second type 'Symbolic Reference.' I shall also endeavour to illustrate the doctrine that all human symbolism, however superficial it may seem, is ultimately to be reduced to trains of this fundamental symbolic reference, trains which finally connect percepts in alternative modes of direct recognition.

5. *Definition of Symbolism*

After this prefatory explanation, we must start from a formal definition of symbolism: The human mind is functioning symbolically when some components of its experience elicit consciousness, beliefs, emotions, and usages, respecting other components of its experience. The former set of components are the 'symbols,' and the latter set constitute the 'meaning' of the symbols. The organic functioning whereby there is transition from the symbol to the meaning will be called 'symbolic reference.'

This symbolic reference is the active synthetic element contributed by the nature of the percipient. It requires a ground founded on some community between the natures of symbol and meaning. But such a common element in the two natures does not of itself necessitate symbolic reference, nor does it decide which shall be symbol and which shall be meaning, nor does it secure that the symbolic reference shall be immune from producing errors and disasters for the percipient. We must conceive perception in the light of a primary phase in the self-production of an occasion of actual existence.

In defence of this notion of self-production arising out of some primary given phase, I would remind you that, apart from it, there can be no moral responsibility. The potter, and not the pot, is responsible for the shape of the pot. An actual occasion arises as the bringing together into one real context diverse perceptions, diverse feelings, diverse purposes, and other diverse activities arising out of

those primary perceptions. Here activity is another name for self-production.

6. *Experience as Activity*

In this way we assign to the percipient an activity in the production of its own experience, although that moment of experience, in its character of being that one occasion, is nothing else than the percipient itself. Thus, for the percipient at least, the perception is an internal relationship between itself and the things perceived.

In analysis the total activity involved in perception of the symbolic reference must be referred to the percipient. Such symbolic reference requires something in common between symbol and meaning which can be expressed without reference to the perfected percipient; but it also requires some activity of the percipient which can be considered without recourse either to the particular symbol or its particular meaning. Considered by themselves the symbol and its meaning do not require *either* that there shall be a symbolic reference between the two, *or* that the symbolic reference between the members of the couple should be one way on rather than the other way on. The nature of their relationship does not in itself determine which is symbol and which is meaning. There are no components of experience which are only symbols or only meanings. The more usual symbolic reference is from the less primitive component as symbol to the more primitive as meaning.

This statement is the foundation of a thorough-going realism. It does away with any mysterious element in our experience which is merely meant, and thereby behind the veil of direct perception. It proclaims the principle that symbolic reference holds between two components in a complex experience, each intrinsically capable of direct recognition. Any lack of such conscious analytical recognition is the fault of the defect in mentality on the part of a comparatively low-grade percipient.

7. *Language*

To exemplify the inversion of symbol and meaning, consider language and the things meant by language. A word is a symbol. But a word can be either written or spoken. Now on occasions a written word may suggest the corresponding spoken word, and that sound may suggest a meaning.

In such an instance, the written word is a symbol and its meaning is the spoken word, and the spoken word is a symbol and its meaning is the dictionary meaning of the word, spoken or written.

But often the written word effects its purpose without the intervention of the spoken word. Accordingly, then, the written word directly symbolizes the dictionary meaning. But so fluctuating and complex is human experience that in general neither of these cases is exemplified in the clear-cut way which is set out here. Often the written word suggests both the spoken word and also the meaning, and the symbolic reference is made clearer and more definite by the additional reference of the spoken word to the same meaning. Analogously we can start from the spoken word which may elicit a visual perception of the written word.

Further, why do we say that the word 'tree'—spoken or written—is a symbol to us for trees? Both the word itself and trees themselves enter into our experience on equal terms; and it would be just as sensible, viewing the question abstractedly, for trees to symbolize the word 'tree' as for the word to symbolize the trees.

This is certainly true, and human nature sometimes works that way. For example, if you are a poet and wish to write a lyric on trees, you will walk into the forest in order that the trees may suggest the appropriate words. Thus for the poet in his ecstasy—or perhaps, agony—of composition the trees are the symbols and the words are the meaning. He concentrates on the trees in order to get at the words.

But most of us are not poets, though we read their lyrics with proper respect. For us, the words are the symbols which enable us to capture the rapture of the poet in the forest. The poet is a person for whom visual sights and sounds and emotional experiences refer symbolically to words. The poet's readers are people for whom his words refer symbolically to the visual sights and sounds and emotions he wants to evoke. Thus in the use of language there is a double symbolic reference:—from things to words on the part of the speaker, and from words back to things on the part of the listener.

When in an act of human experience there is a symbolic reference, there are in the first place two sets of components with some objective relationship between them, and this relationship will vary greatly in different instances. In the second place the total constitution of the percipient has to effect the symbolic reference from one set

of components, the symbols, to the other set of components, the meaning. In the third place, the question, as to which set of components forms the symbols and which set the meaning, also depends on the peculiar constitution of that act of experience.

8. *Presentational Immediacy*

The most fundamental exemplification of symbolism has already been alluded to in the discussion of the poet and the circumstances which elicit his poetry. We have here a particular instance of the reference of words to things. But this general relation of words to things is only a particular instance of a yet more general fact. Our perception of the external world is divided into two types of content: one type is the familiar immediate presentation of the contemporary world, by means of our projection of our immediate sensations, determining for us characteristics of contemporary physical entities. This type is the experience of the immediate world around us, a world decorated by sense-data dependent on the immediate states of relevant parts of our own bodies. Physiology establishes this latter fact conclusively; but the physiological details are irrelevant to the present philosophical discussion, and only confuse the issue. 'Sense-datum' is a modern term: Hume uses the word 'impression.'

For human beings, this type of experience is vivid, and is especially distinct in its exhibition of the spatial regions and relationships within the contemporary world.

The familiar language which I have used in speaking of the 'projection of our sensations' is very misleading. There are no bare sensations which are first experienced and then 'projected' into our feet as their feelings, or onto the opposite wall as its colour. The projection is an integral part of the situation, quite as original as the sense-data. It would be just as accurate, and equally misleading, to speak of a projection on the wall which is then characterized as such-and-such a colour. The use of the term 'wall' is equally misleading by its suggestion of information derived symbolically from another mode of perception. This so-called 'wall,' disclosed in the pure mode of presentational immediacy, contributes itself to our experience only under the guise of spatial extension, combined with spatial perspective, and combined with sense-data which in this example reduce to colour alone.

I say that the wall contributes *itself* under this guise, in preference

to saying that it contributes these universal characters in combination. For the characters are combined by their exposition of one thing in a common world including ourselves, that one thing which I call the 'wall.' Our perception is not confined to universal characters; we do not perceive disembodied colour or disembodied extensiveness: we perceive *the wall's* colour and extensiveness. The experienced fact is 'colour away on the wall for us.' Thus the colour and the spatial perspective are abstract elements, characterizing the concrete way in which the wall enters into our experience. They are therefore relational elements between the 'percipient at that moment,' and that other equally actual entity, or set of entities, which we call the 'wall at that moment.' But the mere colour and the mere spatial perspective are very abstract entities, because they are only arrived at by discarding the concrete relationship between the wall-at-that-moment and the percipient-at-that-moment. This concrete relationship is a physical fact which may be very unessential to the wall and very essential to the percipient. The spatial relationship is equally essential both to wall and percipient: but the colour side of the relationship is at that moment indifferent to the wall, though it is part of the make-up of the percipient. In this sense, and subject to their spatial relationship, contemporary events happen independently. I call this type of experience 'presentational immediacy.' It expresses how contemporary events are relevant to each other, and yet preserve a mutual independence. This relevance amid independence is the peculiar character of contemporaneousness. This presentational immediacy is only of importance in high-grade organisms, and is a physical fact which may, or may not, enter into consciousness. Such entry will depend on attention and on the activity of conceptual functioning, whereby physical experience and conceptual imagination are fused into knowledge.

9. *Perceptive Experience*

The word 'experience' is one of the most deceitful in philosophy. Its adequate discussion would be the topic for a treatise. I can only indicate those elements in my analysis of it which are relevant to the present train of thought.

Our experience, so far as it is primarily concerned with our direct recognition of a solid world of other things which are actual in the same sense that we are actual, has three main independent modes each

contributing its share of components to our individual rise into one concrete moment of human experience. Two of these modes of experience I will call perceptive, and the third I will call the mode of conceptual analysis. In respect to pure perception, I call one of the two types concerned the mode of 'presentational immediacy,' and the other the mode of 'causal efficacy.' Both 'presentational immediacy' and 'causal efficacy' introduce into human experience components which are again analysable into actual things of the actual world and into abstract attributes, qualities, and relations, which express how those other actual things contribute themselves as components to our individual experience. These abstractions express how other actualities are component objects for us. I will therefore say that they 'objectify' for us the actual things in our 'environment.' Our most immediate environment is constituted by the various organs of our own bodies, our more remote environment is the physical world in the neighbourhood. But the word 'environment' means those other actual things, which are 'objectified' in some important way so as to form component elements in our individual experience.

10. *Symbolic Reference in Perceptive Experience*

Of the two distinct perceptive modes, one mode 'objectifies' actual things under the guise of presentational immediacy, and the other mode, which I have not yet discussed, 'objectifies' them under the guise of causal efficacy. The synthetic activity whereby these two modes are fused into one perception is what I have called 'symbolic reference.' By symbolic reference the various actualities disclosed respectively by the two modes are either identified, or are at least correlated together as interrelated elements in our environment. Thus the result of symbolic reference is what the actual world is for us, as that datum in our experience productive of feelings, emotions, satisfactions, actions, and finally as the topic for conscious recognition when our mentality intervenes with its conceptual analysis. 'Direct recognition' is conscious recognition of a percept in a pure mode, devoid of symbolic reference.

Symbolic reference may be, in many respects, erroneous. By this I mean that some 'direct recognition' disagrees, in its report of the actual world, with the conscious recognition of the fused product resulting from symbolic reference. Thus error is primarily the product

of symbolic reference, and not of conceptual analysis. Also symbolic reference itself is not primarily the outcome of conceptual analysis, though it is greatly promoted by it. For symbolic reference is still dominant in experience when such mental analysis is at a low ebb. We all know Aesop's fable of the dog who dropped a piece of meat to grasp at its reflection in the water. We must not, however, judge too severely of error. In the initial stages of mental progress, error in symbolic reference is the discipline which promotes imaginative freedom. Aesop's dog lost his meat, but he gained a step on the road towards a free imagination.

Thus symbolic reference must be explained antecedently to conceptual analysis, although there is a strong interplay between the two whereby they promote each other.

11. *Mental and Physical*

By way of being as intelligible as possible we might tacitly assign symbolic reference to mental activity, and thereby avoid some detailed explanation. It is a matter of pure convention as to which of our experiential activities we term mental and which physical. Personally I prefer to restrict mentality to those experiential activities which include concepts in addition to percepts. But much of our perception is due to the enhanced subtlety arising from a concurrent conceptual analysis. Thus in fact there is no proper line to be drawn between the physical and the mental constitution of experience. But there is no conscious knowledge apart from the intervention of mentality in the form of conceptual analysis.

It will be necessary later on to make some slight reference to conceptual analysis; but at present I must assume consciousness and its partial analysis of experience, and return to the two modes of pure perception. The point that I want to make here is, that the reason why low-grade purely physical organisms cannot make mistakes is not primarily their absence of thought, but their absence of presentational immediacy. Aesop's dog, who was a poor thinker, made a mistake by reason of an erroneous symbolic reference from presentational immediacy to causal efficacy. In short, truth and error dwell in the world by reason of synthesis: every actual thing is synthetic: and symbolic reference is one primitive form of synthetic activity whereby what is actual arises from its given phases.

12. *Rôles of Sense-Data and Space in Presentational Immediacy*

By 'presentational immediacy' I mean what is usually termed 'sense-perception.' But I am using the former term under limitations and extensions which are foreign to the common use of the latter term.

Presentational immediacy is our immediate perception of the contemporary external world, appearing as an element constitutive of our own experience. In this appearance the world discloses itself to be a community of actual things, which are actual in the same sense as we are.

This appearance is effected by the mediation of qualities, such as colours, sounds, tastes, etc., which can with equal truth be described as our sensations or as the qualities of the actual things which we perceive. These qualities are thus relational between the perceiving subject and the perceived things. They can be thus isolated only by abstracting them from their implication in the scheme of spatial relatedness of the perceived things to each other and to the perceiving subject. This relatedness of spatial extension is a complete scheme, impartial between the observer and the perceived things. It is the scheme of the morphology of the complex organisms forming the community of the contemporary world. The way in which each actual physical organism enters into the make-up of its contemporaries has to conform to this scheme. Thus the sense-data, such as colours, etc., or bodily feelings, introduce the extended physical entities into our experience under perspectives provided by this spatial scheme. The spatial relations by themselves are generic abstractions, and the sense-data are generic abstractions. But the perspectives of the sense-data provided by the spatial relations are the specific relations whereby the external contemporary things are to this extent part of our experience. These contemporary organisms, thus introduced as 'objects' into experience, include the various organs of our body, and the sense-data are then called bodily feelings. The bodily organs, and those other external things which make important contributions to this mode of our perception, together form the contemporary environment of the percipient organism. The main facts about presentational immediacy are: (i) that the sense-data involved

depend on the percipient organism and its spatial relations to the perceived organisms; (ii) that the contemporary world is exhibited as extended and as a plenum of organisms; (iii) that presentational immediacy is an important factor in the experience of only a few high-grade organisms, and that for the others it is embryonic or entirely negligible.

Thus the disclosure of a contemporary world by presentational immediacy is bound up with the disclosure of the solidarity of actual things by reason of their participation in an impartial system of spatial extension. Beyond this, the knowledge provided by pure presentational immediacy is vivid, precise, and barren. It is also to a large extent controllable at will. I mean that one moment of experience can predetermine to a considerable extent, by inhibitions, or by intensifications, or by other modifications, the characteristics of the presentational immediacy, in succeeding moments of experience. This mode of perception, taken purely by itself, is barren, because we may not directly connect the qualitative presentations of other things with any intrinsic characters of those things. We see the image of a coloured chair, presenting to us the space behind a mirror; yet we thereby gain no knowledge concerning any intrinsic characters of spaces behind the mirror. But the image thus seen in a good mirror is just as much an immediate presentation of colour qualifying the world at a distance behind the mirror, as is our direct vision of the chair when we turn round and look at it. Pure presentational immediacy refuses to be divided into delusions and not-delusions. It is either all of it, or none of it, an immediate presentation of an external contemporary world as in its own right spatial. The sense-data involved in presentational immediacy have a wider relationship in the world than these contemporary things can express. In abstraction from this wider relationship, there is no means of determining the importance of the apparent qualification of contemporary objects by sense-data. For this reason the phrase 'mere appearance' carries the suggestion of barrenness. This wider relationship of the sense-data can only be understood by examining the alternative mode of perception, the mode of causal efficacy. But in so far as contemporary things are bound together by mere presentational immediacy, they happen in complete independence except for their spatial relations at the moment. Also for most events, we presume that their intrinsic experience of presentational immediacy is so

embryonic as to be negligible. This perceptive mode is important only for a small minority of elaborate organisms.

13. *Objectification*

In this explanation of Presentational Immediacy, I am conforming to the distinction according to which actual things are *objectively* in our experience and *formally* existing in their own completeness. I maintain that presentational immediacy is that peculiar way in which contemporary things are 'objectively' in our experience, and that among the abstract entities which constitute factors in the mode of introduction are those abstractions usually called sense-data:—for example, colours, sounds, tastes, touches, and bodily feelings.

Thus 'objectification' itself is abstraction; since no actual thing is 'objectified' in its 'formal' completeness. Abstraction expresses nature's mode of interaction and is not merely mental. When it abstracts, thought is merely conforming to nature—or rather, it is exhibiting itself as an element in nature. Synthesis and analysis require each other. Such a conception is paradoxical if you will persist in thinking of the actual world as a collection of passive actual substances with their private characters or qualities. In that case, it must be nonsense to ask, how one such substance can form a component in the make-up of another such substance. So long as this conception is retained, the difficulty is not relieved by calling each actual substance an event, or a pattern, or an occasion. The difficulty, which arises for such a conception, is to explain how the substances can be actually together in a sense derivative from that in which each individual substance is actual. But the conception of the world here adopted is that of functional activity. By this I mean that every actual thing is something by reason of its activity; whereby its nature consists in its relevance to other things, and its individuality consists in its synthesis of other things so far as they are relevant to it. In enquiring about any one individual we must ask how other individuals enter 'objectively' into the unity of its own experience. This unity of its own experience is that individual existing *formally*. We must also enquire how it enters into the 'formal' existence of other things; and this entrance is that individual existing *objectively*, that is to say —existing abstractly, exemplifying only some elements in its formal content.

With this conception of the world, in speaking of any actual indi-

vidual, such as a human being, we must mean that man in one occasion of his experience. Such an occasion, or act, is complex and therefore capable of analysis into phases and other components. It is the most concrete actual entity, and the life of man from birth to death is a historic route of such occasions. These concrete moments are bound together into one society by a partial identity of form, and by the peculiarly full summation of its predecessors which each moment of the life-history gathers into itself. The man-at-one-moment concentrates in himself the colour of his own past, and he is the issue of it. The 'man in his whole life history' is an abstraction compared to the 'man in one such moment.' There are therefore three different meanings for the notion of a particular man,—Julius Cæsar, for example. The word 'Caesar' may mean 'Caesar in some one occasion of his existence': this is the most concrete of all the meanings. The word 'Caesar' may mean 'the historic route of Caesar's life from his Caesarian birth to his Caesarian assassination.' The word 'Caesar' may mean 'the common form, or pattern, repeated in each occasion of Caesar's life.' You may legitimately choose any one of these meaning; but when you have made your choice, you must in that context stick to it.

This doctrine of the nature of the life-history of an enduring organism holds for all types of organisms, which have attained to unity and experience, for electrons as well as for men. But mankind has gained a richness of experiential content denied to electrons. Whenever the 'all or none' principle holds, we are in some way dealing with one actual entity, and not with a society of such entities, nor with the analysis of components contributory to one such entity.

This lecture has maintained the doctrine of a direct experience of an external world. It is impossible fully to argue this thesis without getting too far away from my topic. I need only refer you to the first portion of Santayana's recent book, *Scepticism and Animal Faith,* for a conclusive proof of the futile 'solipsism of the present moment'—or, in other words, utter scepticism—which results from a denial of this assumption. My second thesis, for which I cannot claim Santayana's authority, is that, if you consistently maintain such direct individual experience, you will be driven in your philosophical construction to a conception of the world as an interplay of functional activity whereby each concrete individual thing arises from its determinate relativity to the settled world of other concrete individuals, at least so far as the world is past and settled.

CHAPTER II

1. *Hume on Causal Efficacy*

It is the thesis of this work that human symbolism has its origin in the symbolic interplay between two distinct modes of direct perception of the external world. There are, in this way, two sources of information about the external world, closely connected but distinct. These modes do not repeat each other; and there is a real diversity of information. Where one is vague, the other is precise: where one is important, the other is trivial. But the two schemes of presentation have structural elements in common, which identify them as schemes of presentation of the same world. There are however gaps in the determination of the correspondence between the two morphologies. The schemes only partially intersect, and their true fusion is left indeterminate. The symbolic reference leads to a transference of emotion, purpose, and belief, which cannot be justified by an intellectual comparison of the direct information derived from the two schemes and their elements of intersection. The justification, such as it is, must be sought in a pragmatic appeal to the future. In this way intellectual criticism founded on subsequent experience can enlarge and purify the primitive naïve symbolic transference.

I have termed one perceptive mode 'Presentational Immediacy,' and the other mode 'Causal Efficacy.' In the previous lecture the mode of presentational immediacy was discussed at length. The present lecture must commence with the discussion of 'Causal Efficacy.' It will be evident to you that I am here controverting the most cherished tradition of modern philosophy, shared alike by the school of empiricists which derives from Hume, and the school of transcendental idealists which derives from Kant. It is unnecessary to enter upon any prolonged justification of this summary account of the tradition of modern philosophy. But some quotations will summarize neatly what is shared in common by the two types of thought from which I am diverging. Hume * writes:—'When both the objects are present to the senses along with the relation, we call *this* perception rather than reasoning; nor is there in this case any exercise of the thought, or any action, properly speaking, but a mere passive admis-

* *Treatise,* Part III, Sec. II.

sion of the impressions through the organs of sensation. According to this way of thinking, we ought not to receive as reasoning any of the observations we may make concerning *identity,* and the *relations* of *time* and *place;* since in none of them the mind can go beyond what is immediately present to the senses, either to discover the real existence or the relations of objects.'

The whole force of this passage depends upon the tacit presupposition of the 'mind' as a passively receptive substance and of its 'impression' as forming its private world of accidents. There then remains nothing except the immediacy of these private attributes with their private relations which are also attributes of the mind. Hume explicitly repudiates this substantial view of mind.

But then, what is the force of the last clause of the last sentence, 'since . . . objects?' The only reason for dismissing 'impressions' from having any demonstrative force in respect to 'the *real* existence or the relations of objects,' is the implicit notion that such impressions are mere private attributes of the mind. Santayana's book, *Scepticism and Animal Faith,* to which I have already referred, is in its earlier chapters a vigorous and thorough insistence, by every manner of beautiful illustration, that with Hume's premises there is no manner of escape from this dismissal of identity, time, and place from having any reference to a real world. There remains only what Santayana calls 'Solipsism of the Present Moment.' Even memory goes: for a memory-impression is not an impression of memory. It is only another immediate private impression.

It is unnecessary to cite Hume on Causation; for the preceding quotation carries with it his whole sceptical position. But a quotation * on substance is necessary to explain the ground of his explicit —as distinct from sporadic implicit presuppositions—doctrine on this point:—'I would fain ask those philosophers, who found so much of their reasonings on the distinction of substance and accident, and imagine we have clear ideas of each, whether the idea of *substance* be derived from the impressions of sensation or reflection? If it be conveyed to us by our senses, I ask, which of them, and after what manner? If it be perceived by the eyes, it must be a colour; if by the ears, a sound; if by the palate, a taste; and so of the other senses. But I believe none will assert that substance is a colour, or sound,

* *Treatise,* Part I, Sec. VI.

or a taste. The idea of substance must, therefore, be derived from an impression of reflection, if it really exist. But the impressions of reflection resolve themselves into our passions and emotions; none of which can possibly represent a substance. We have, therefore, no idea of substance, distinct from that of a collection of particular qualities, nor have we any other meaning when we either talk or reason concerning it.'

This passage is concerned with a notion of 'substance,' which I do not entertain. Thus it only indirectly controverts my position. I quote it because it is the plainest example of Hume's initial assumptions that (i) presentational immediacy, and relations between presentationally immediate entities, constitute the only type of perceptive experience, and that (ii) presentational immediacy includes no demonstrative factors disclosing a contemporary world of extended actual things.

He discusses this question later in his 'Treatise' under the heading of the notion of 'Bodies'; and arrives at analogous sceptical conclusions. These conclusions rest upon an extraordinary naïve assumption of time as pure succession. The assumption is naïve, because it is the natural thing to say; it is natural because it leaves out that characteristic of time which is so intimately interwoven that it is natural to omit it.

Time is known to us as the succession of our acts of experience, and thence derivatively as the succession of events objectively perceived in those acts. But this succession is not pure succession: it is the derivation of state from state, with the later state exhibiting conformity to the antecedent. Time in the concrete is the conformation of state to state, the later to the earlier; and the pure succession is an abstraction from the irreversible relationship of settled past to derivative present. The notion of pure succession is analogous to the notion of colour. There is no mere colour, but always some particular colour such as red or blue: analogously there is no pure succession, but always some particular relational ground in respect to which the terms succeed each other. The integers succeed each other in one way, and events succeed each other in another way; and, when we abstract from these ways of succession, we find that pure succession is an abstraction of the second order, a generic abstraction omitting the temporal character of time and the numerical relation

of integers. The past consists of the community of settled acts which, through their objectifications in the present act, establish the conditions to which that act must conform.

Aristotle conceived 'matter'—ὑλή—as being pure potentiality awaiting the incoming of form in order to become actual. Hence employing Aristotelian notions, we may say that the limitation of pure potentiality, established by 'objectifications' of the settled past, expresses that 'natural potentiality'—or, potentiality in nature—which is 'matter' with that basis of initial, realized form presupposed as the first phase in the self-creation of the present occasion. The notion of 'pure potentiality' here takes the place of Aristotle's 'matter,' and 'natural potentiality' is 'matter' with that given imposition of form from which each actual thing arises. All components which are *given* for experience are to be found in the analysis of natural potentiality. Thus the immediate present has to conform to what the past is for it, and the mere lapse of time is an abstraction from the more concrete relatedness of 'conformation.' The 'substantial' character of actual things is not primarily concerned with the predication of qualities. It expresses the stubborn fact that whatever is settled and actual must in due measure be conformed to by the self-creative activity. The phrase 'stubborn fact' exactly expresses the popular apprehension of this characteristic. Its primary phase, from which each actual thing arises, is the stubborn fact which underlies its existence. According to Hume there are no stubborn facts. Hume's doctrine may be good philosophy, but it is certainly not common sense. In other words, it fails before the final test of obvious verification.

2. *Kant and Causal Efficacy*

The school of transcendental idealists, derived from Kant, admit that causal efficacy is a factor in the phenomenal world; but hold that it does not belong to the sheer data presupposed in perception. It belongs to our ways of thought about the data. Our consciousness of the perceived world yields us an objective system, which is a fusion of mere data and modes of thought about those data.

The general Kantian reason for this position is that direct perception acquaints us with particular fact. Now particular fact is what simply occurs as particular datum. But we believe universal principles about all particular facts. Such universal knowledge cannot be

derived from any selection of particular facts, each of which has just simply occurred. Thus our ineradicable belief is only explicable by reason of the doctrine that particular facts, as consciously apprehended, are the fusion of mere particular data with thought functioning according to categories which import their own universality in the modified data. Thus the phenomenal world, as in consciousness, is a complex of coherent judgments, framed according to fixed categories of thought, and with a content constituted by given data organized according to fixed forms of intuition.

This Kantian doctrine accepts Hume's naïve presupposition of 'simple occurrence' for the mere data. I have elsewhere called it the assumption of 'simple location,' by way of applying it to space as well as to time.

I directly deny this doctrine of 'simple occurrence.' There is nothing which 'simply happens.' Such a belief is the baseless doctrine of time as 'pure succession.' The alternative doctrine, that the pure succession of time is merely an abstract from the fundamental relationship of conformation, sweeps away the whole basis for the intervention of constitutive thought, or constitutive intuition, in the formation of the directly apprehended world. Universality of truth arises from the universality of relativity, whereby every particular actual thing lays upon the universe the obligation of conforming to it. Thus in the analysis of particular fact universal truths are discoverable, those truths expressing this obligation. The given-ness of experience—that is to say, all its data alike, whether general truths or particular sensa or presupposed forms of synthesis—expresses the specific character of the temporal relation of that act of experience to the settled actuality of the universe which is the source of all conditions. The fallacy of 'misplaced concreteness' abstracts from time this specific character, and leaves time with the mere generic character of pure succession.

3. *Direct Perception of Causal Efficacy*

The followers of Hume and the followers of Kant have thus their diverse, but allied, objections to the notion of any direct perception of causal efficacy, in the sense in which direct perception is antecedent to thought about it. Both schools find 'causal efficacy' to be the importation, into the data, of a way of thinking or judging about

those data. One school calls it a habit of thought; the other school calls it a category of thought. Also for them the mere data are the pure sense-data.

If either Hume or Kant gives a proper account of the status of causal efficacy, we should find that our conscious apprehension of causal efficacy should depend to some extent on the vividness of the thought or of the pure intuitive discrimination of sense-data at the moment in question. For an apprehension which is the product of thought should sink in importance when thought is in the background. Also, according to this Humian-Kantian account, the thought in question is thought about the immediate sense-data. Accordingly a certain vividness of sense-data in immediate presentation should be favourable to apprehension of causal efficacy. For according to these accounts, causal efficacy is nothing else than a way of thinking about sense-data, given in presentational immediacy. Thus the inhibition of thought and the vagueness of sense-data should be extremely unfavourable to the prominence of causal efficacy as an element in experience.

The logical difficulties attending the direct perception of causal efficacy have been shown to depend on the sheer assumption that time is merely the generic notion of pure succession. This is an instance of the fallacy of 'misplaced concreteness.' Thus the way is now open to enquire empirically whether in fact our apprehension of causal efficacy does depend either on the vividness of sense-data or on the activity of thought.

According to both schools, the importance of causal efficacy, and of action exemplifying its presupposition, should be mainly characteristic of high-grade organisms in their best moments. Now if we confine attention to long-range identification of cause and effect, depending on complex reasoning, undoubtedly such high-grade mentality and such precise determination of sense-data are required. But each step in such reasoning depends on the primary presupposition of the immediate present moment conforming itself to the settled environment of the immediate past. We must not direct attention to the inferences from yesterday to today, or even from five minutes ago to the immediate present. We must consider the immediate present in its relationship to the immediate past. The overwhelming conformation of fact, in present action, to antecedent settled fact is to be found here.

My point is that this conformation of present fact to immediate past is more prominent both in apparent behaviour and in consciousness, when the organism is low grade. A flower turns to the light with much greater certainty than does a human being, and a stone conforms to the conditions set by its external environment with much greater certainty than does a flower. A dog anticipates the conformation of the immediate future to his present activity with the same certainty as a human being. When it comes to calculations and remote inferences, the dog fails. But the dog never acts as though the immediate future were irrelevant to the present. Irresolution in action arises from consciousness of a somewhat distant relevant future, combined with inability to evaluate its precise type. If we were not conscious of relevance, why is there irresolution in a sudden crisis?

Again a vivid enjoyment of immediate sense-data notoriously inhibits apprehension of the relevance of the future. The present moment is then all in all. In our consciousness it approximates to 'simple occurrence.'

Certain emotions, such as anger and terror, are apt to inhibit the apprehension of sense-data; but they wholly depend upon a vivid apprehension of the relevance of immediate past to the present, and of the present to the future. Again an inhibition of familiar sense-data provokes the terrifying sense of vague presences, effective for good or evil over our fate. Most living creatures, of daytime habits, are more nervous in the dark, in the absence of the familiar visual sense-data. But according to Hume, it is the very familiarity of the sense-data which is required for causal inference. Thus the sense of unseen effective presences in the dark is the opposite of what should happen.

4. *Primitiveness of Causal Efficacy*

The perception of conformation to realities in the environment is the primitive element in our external experience. We conform to our bodily organs and to the vague world which lies beyond them. Our primitive perception is that of 'conformation' vaguely, and of the yet vaguer relata 'oneself' and 'another' in the undiscriminated background. Of course if relationships are unperceivable, such a doctrine must be ruled out on theoretic grounds. But if we admit such perception, then the perception of conformation has every mark of a primi-

tive element. One part of our experience is handy, and definite in our consciousness; also it is easy to reproduce at will. The other type of experience, however insistent, is vague, haunting, unmanageable. The former type, for all its decorative sense-experience, is barren. It displays a world concealed under an adventitious show, a show of our own bodily production. The latter type is heavy with the contact of the things gone by, which lay their grip on our immediate selves. This latter type, the mode of causal efficacy, is the experience dominating the primitive living organisms, which have a sense for the fate from which they have emerged, and for the fate towards which they go—the organisms which advance and retreat but hardly differentiate any immediate display. It is a heavy, primitive experience. The former type, the presentational immediacy, is the superficial product of complexity, of subtlety; it halts at the present, and indulges in a manageable self-enjoyment derived from the immediacy of the show of things. Those periods in our lives—when the perception of the pressure from a world of things with characters in their own right, characters mysteriously moulding our own natures, become strongest—those periods are the product of a reversion to some primitive state. Such a reversion occurs when either some primitive functioning of the human organism is unusually heightened, or some considerable part of our habitual sense-perception is unusually enfeebled.

Anger, hatred, fear, terror, attraction, love, hunger, eagerness, massive enjoyment, are feelings and emotions closely entwined with the primitive functioning of 'retreat from' and of 'expansion towards.' They arise in the higher organism as states due to a vivid apprehension that some such primitive mode of functioning is dominating the organism. But 'retreat from' and 'expansion towards,' divested of any detailed spatial discrimination, are merely reactions to the way externality is impressing on us its own character. You cannot retreat from mere subjectivity; for subjectivity is what we carry with us. Normally, we have almost negligible sense-presentations of the interior organs of our own bodies.

These primitive emotions are accompanied by the clearest recognition of other actual things reacting upon ourselves. The vulgar obviousness of such recognition is equal to the vulgar obviousness produced by the functioning of any one of our five senses. When we hate, it is a man that we hate and not a collection of sense-data—a

causal, efficacious man. This primitive obviousness of the perception of 'conformation' is illustrated by the emphasis on the pragmatic aspect of occurrences, which is so prominent in modern philosophical thought. There can be no useful aspect of anything unless we admit the principle of conformation, whereby what is already made becomes a determinant of what is in the making. The obviousness of the pragmatic aspect is simply the obviousness of the perception of the fact of conformation.

In practice we never doubt the fact of the conformation of the present to the immediate past. It belongs to the ultimate texture of experience, with the same evidence as does presentational immediacy. The present fact is luminously the outcome from its predecessors, one quarter of a second ago. Unsuspected factors may have intervened; dynamite may have exploded. But, however that may be, the present event issues subject to the limitations laid upon it by the actual nature of the immediate past. If dynamite explodes, then present fact is that issue from the past which is consistent with dynamite exploding. Further, we unhesitatingly argue backwards to the inference, that the complete analysis of the past must disclose in it those factors which provide the conditions for the present. If dynamite be now exploding, then in the immediate past there was a charge of dynamite unexploded.

The fact that our consciousness is confined to an analysis of experience in the present is no difficulty. For the theory of the universal relativity of actual individual things leads to the distinction between the present moment of experience, which is the sole datum for conscious analysis, and perception of the contemporary world, which is the only one factor in this datum.

The contrast between the comparative emptiness of Presentational Immediacy and the deep significance disclosed by Causal Efficacy is at the root of the pathos which haunts the world.

'Pereunt et imputantur'

is the inscription on old sundials in 'religious' houses:

'The hours perish and are laid to account.'

Here 'Pereunt' refers to the world disclosed in immediate presentation, gay with a thousand tints, passing, and intrinsically meaningless. 'Imputantur' refers to the world disclosed in its causal efficacy, where

each event infects the ages to come, for good or for evil, with its own individuality. Almost all pathos includes a reference to lapse of time.

The final stanza of Keats' *Eve of St. Agnes* commences with the haunting lines:

> 'And they are gone: ay, ages long ago
> Those lovers fled away into the storm.'

There the pathos of the lapse of time arises from the imagined fusion of the two perceptive modes by one intensity of emotion. Shakespeare, in the springtime of the modern world, fuses the two elements by exhibiting the infectiousness of gay immediacy:

> '. . . daffodils,
> That come before the swallow dares, and take
> The winds of March with beauty; . . .'
> (The Winter's Tale, IV, iv, 118–120)

But sometimes men are overstrained by their undivided attention to the causal elements in the nature of things. Then in some tired moment there comes a sudden relaxation, and the mere presentational side of the world overwhelms with the sense of its emptiness. As William Pitt, the Prime Minister of England through the darkest period of the French Revolutionary wars, lay on his death-bed at England's worst moment in that struggle, he was heard to murmur, 'What shades we are, what shadows we pursue!' His mind had suddenly lost the sense of causal efficacy, and was illuminated by the remembrance of the intensity of emotion, which had enveloped his life, in its comparison with the barren emptiness of the world passing in sense-presentation.

The world, given in sense-presentation, is not the aboriginal experience of the lower organisms, later to be sophisticated by the inference to causal efficacy. The contrary is the case. First the causal side of experience is dominating, then the sense-presentation gains in subtlety. Their mutual symbolic reference is finally purged by consciousness and the critical reason with the aid of a pragmatic appeal to consequences.

5. *The Intersection of the Modes of Perception*

There cannot be symbolic reference between percepts derived from one mode and percepts from the other mode, unless in some

way these percepts intersect. By this 'intersection' I mean that a pair of such percepts must have elements of structure in common, whereby they are marked out for the action of symbolic reference.

There are two elements of common structure, which can be shared in common by a percept derived from presentational immediacy and by another derived from causal efficacy. These elements are (1) sense-data, and (2) locality.

The sense-data are 'given' for presentational immediacy. This given-ness of sense-data, as the basis of this perceptive mode, is the great doctrine common to Hume and Kant. But what is already given for experience can only be derived from that natural potentiality which shapes a particular experience in the guise of causal efficacy. Causal efficacy is the hand of the settled past in the formation of the present. The sense-data must therefore play a double rôle in perception. In the mode of presentational immediacy they are projected to exhibit the contemporary world in its spatial relations. In the mode of causal efficacy they exhibit the almost instantaneously precedent bodily organs as imposing their characters on the experience in question. We see the picture, and we see it with our eyes; we touch the wood, and we touch it with our hands; we smell the rose, and we smell it with our nose; we hear the bell, and we hear it with our ears; we taste the sugar, and we taste it with our palate. In the case of bodily feelings the two locations are identical. The foot is both giving pain and is the seat of the pain. Hume himself tacitly asserts this double reference in the second of the quotations previously made. He writes: 'If it be perceived by the eyes, it must be a colour; if by the ears, a sound; if by the palate, a taste; and so of the other senses.' Thus in asserting the lack of perception of causality, he implicitly presupposes it. For what is the meaning of 'by' in 'by the eyes,' 'by the ears,' 'by the palate'? His argument presupposes that sense-data, functioning in presentational immediacy, are 'given' by reason of 'eyes,' 'ears,' 'palates' functioning in causal efficacy. Otherwise his argument is involved in a vicious regress. For it must begin again over eyes, ears, palates; also it must explain the meaning of 'by' and 'must' in a sense which does not destroy his argument.

This double reference is the basis of the whole physiological doctrine of perception. The details of this doctrine are, in this discussion, philosophically irrelevant. Hume with the clarity of genius states the

fundamental point, that sense-data functioning in an act of experience demonstrate that they are given *by* the causal efficacy of actual bodily organs. He refers to this causal efficacy as a component in direct perception. Hume's argument first tacitly presupposes the two modes of perception, and then tacitly assumes that presentational immediacy is the only mode. Also Hume's followers in developing his doctrine presuppose that presentational immediacy is primitive, and that causal efficacy is the sophisticated derivative. This is a complete inversion of the evidence. So far as Hume's own teaching is concerned, there is, of course, another alternative: it is that Hume's disciples have misinterpreted Hume's final position. On this hypothesis, his final appeal to 'practice' is an appeal against the adequacy of the then current metaphysical categories as interpretive of obvious experience. This theory about Hume's own beliefs is in my opinion improbable: but, apart from Hume's own estimate of his philosophical achievement, it is in this sense that we must reverence him as one of the greatest of philosophers.

The conclusion of this argument is that the intervention of any sense-datum in the actual world cannot be expressed in any simple way, such as mere qualification of a region of space, or alternatively as the mere qualification of a state of mind. The sense-data, required for immediate sense-perception, enter into experience in virtue of the efficacy of the environment. This environment includes the bodily organs. For example, in the case of hearing sound the physical waves have entered the ears, and the agitations of the nerves have excited the brain. The sound is then heard as coming from a certain region in the external world. Thus perception in the mode of causal efficacy discloses that the data in the mode of sense-perception are provided by it. This is the reason why there are such given elements. Every such datum constitutes a link between the two perceptive modes. Each such link, or datum, has a complex ingression into experience, requiring a reference to the two perceptive modes. These sense-data can be conceived as constituting the character of a many-termed relationship between the organisms of the past environment and those of the contemporary world.

6. *Localization*

The partial community of structure, whereby the two perceptive modes yield immediate demonstration of a common world, arises

from their reference of sense-data, common to both, to localizations, diverse or identical, in a spatio-temporal system common to both. For example, colour is referred to an external space and to the eyes as organs of vision. In so far as we are dealing with one or other of these pure perceptive modes, such reference is direct demonstration; and, as isolated in conscious analysis, is ultimate fact against which there is no appeal. Such isolation, or at least some approach to it, is fairly easy in the case of presentational immediacy, but is very difficult in the case of causal efficacy. Complete ideal purity of perceptive experience, devoid of any symbolic reference, is in practice unobtainable for either perceptive mode.

Our judgments on causal efficacy are almost inextricably warped by the acceptance of the symbolic reference between the two modes as the completion of our direct knowledge. This acceptance is not merely in thought, but also in action, emotion, and purpose, all precedent to thought. This symbolic reference is a datum for thought in its analysis of experience. By trusting this datum, our conceptual scheme of the universe is in general logically coherent with itself, and is correspondent to the ultimate facts of the pure perceptive modes. But occasionally, either the coherence or the verification fails. We then revise our conceptual scheme so as to preserve the general trust in the symbolic reference, while relegating definite details of that reference to the category of errors. Such errors are termed 'delusive appearances.' This error arises from the extreme vagueness of the spatial and temporal perspectives in the case of perception in the pure mode of causal efficacy. There is no adequate definition of localization, so far as what emerges into analytic consciousness. The principle of relativity leads us to hold that, with adequate conscious analysis, such local relationships leave their faint impress in experience. But in general such detailed analysis is far beyond the capacity of human consciousness.

So far as concerns the causal efficacy of the world external to the human body, there is the most insistent perception of a circumambient efficacious world of beings. But exact discrimination of thing from thing, and of position from position, is extremely vague, almost negligible. The definite discrimination, which in fact we do make, arises almost wholly by reason of symbolic reference from presentational immediacy. The case is different in respect to the human body. There is still vagueness in comparison with the accurate definition of

immediate presentation; although the locality of various bodily organs which are efficacious in the regulation of the sense-data, and of the feelings, are fairly well-defined in the pure perceptive mode of causal efficacy. The symbolic transference of course intensifies the definition. But, apart from such transference, there is some adequacy of definite demarcation.

Thus in the intersection of the two modes, the spatial and temporal relationships of the human body, as causally apprehended, to the external contemporary world, as immediately presented, afford a fairly definite scheme of spatial and temporal reference whereby we test the symbolic use of sense-projection for the determination of the positions of bodies controlling the course of nature. Ultimately all observation, scientific or popular, consists in the determination of the spatial relation of the bodily organs of the observer to the location of 'projected' sense-data.

7. *The Contrast Between Accurate Definition and Importance*

The reason why the projected sense-data are in general used as symbol, is that they are handy, definite, and manageable. We can see, or not see, as we like: we can hear, or not hear. There are limits to this handiness of the sense-data: but they are emphatically the manageable elements in our perceptions of the world. The sense of controlling presences has the contrary character: it is unmanageable, vague, and ill-defined.

But for all their vagueness, for all their lack of definition, these controlling presences, these sources of power, these things with an inner life, with their own richness of content, these beings, with the destiny of the world hidden in their natures, are what we want to know about. As we cross a road busy with traffic, we see the colour of the cars, their shapes, the gay colours of their occupants; but at the moment we are absorbed in using this immediate show as a symbol for the forces determining the immediate future.

We enjoy the symbol, but we also penetrate to the meaning. The symbols do not create their meaning: the meaning, in the form of actual effective beings reacting upon us, exists for us in its own right. But the symbols discover this meaning for us. They discover it because, in the long course of adaptation of living organisms to their environment, nature * taught their use. It developed us so that our

* Cf. *Prolegomena to an Idealist Theory of Knowledge,* by Norman Kemp Smith (Macmillan and Co., London, 1924).

projected sensations indicate in general those regions which are the seat of important organisms.

Our relationships to these bodies are precisely our reactions to them. The projection of our sensations is nothing else than the illustration of the world in partial accordance with the systematic scheme, in space and in time, to which these reactions conform.

The bonds of causal efficacy arise from without us. They disclose the character of the world from which we issue, an inescapable condition round which we shape ourselves. The bonds of presentational immediacy arise from within us, and are subject to intensifications and inhibitions and diversions according as we accept their challenge or reject it. The sense-data are not properly to be termed 'mere impressions'—except so far as any technical term will do. They also represent the conditions arising out of the active perceptive functioning as conditioned by our own natures. But our natures must conform to the causal efficacy. Thus the causal efficacy *from* the past is at least one factor giving our presentational immediacy *in* the present. The *how* of our present experience must conform to the *what* of the past in us.

Our experience arises out of the past: it enriches with emotion and purpose its presentation of the contemporary world: and it bequeaths its character to the future, in the guise of an effective element forever adding to, or subtracting from, the richness of the world. For good or for evil,

'Pereunt et imputantur.'

8. *Conclusion*

In this chapter, and in the former chapter, the general character of symbolism has been discussed. It plays a dominant part in the way in which all higher organisms conduct their lives. It is the cause of progress, and the cause of error. The higher animals have gained a faculty of great power, by means of which they can define with some accuracy those distant features in the immediate world by which their future lives are to be determined. But this faculty is not infallible; and the risks are commensurate with its importance. It is the purpose of the next chapter to illustrate this doctrine by an analysis of the part played by this habit of symbolism in promoting the cohesion, the progress, and the dissolution of human societies.

Process and Reality: An Essay in Cosmology

Part I The Speculative Scheme

Chapter I	Speculative Philosophy	567
Chapter II	The Categoreal Scheme	584
Chapter III	Some Derivative Notions	599

Part II Discussions and Applications

Chapter I	Fact and Form	607
Chapter II	The Extensive Continuum	633
Chapter III	The Order of Nature	659
Chapter IV	Organisms and Environment	691
Chapter V	Locke and Hume	715
Chapter VI	From Descartes to Kant	731

PROCESS AND REALITY

Process and Reality, with the subtitle "An Essay in Cosmology," was published in 1929, and comprises Whitehead's Gifford Lectures delivered in the University of Edinburgh in 1927 and 1928. These lectures constitute the most complete and systematic exposition of Whitehead's philosophical position.

The book is divided into five parts. Part I, "The Speculative Scheme," included here in its entirety, sets forth Whitehead's conception of the task of speculative philosophy, and the general outline and categories of his own system. Part II, "Discussions and Applications," of which the first six chapters are included here, contains an account of the application of his general philosophical ideas and categories to the solution of traditional philosophical problems. Here Whitehead is concerned to explain his philosophical position in its relationship to the traditional systems of Western philosophy from Plato to the twentieth century.

Part III, "The Theory of Prehensions," gives a detailed account of the theory which was first introduced in Science and the Modern World, along with a development of Whitehead's own philosophical categories.

Part IV, "The Theory of Extension," takes up again the method of extensive abstraction in a revised form, and will be recognized as belonging to the same strain of Whiteheadian thought which is introduced in this anthology first in On Mathematical Concepts of the Material World.

In Part V, "Final Interpretation," Whitehead carries his analysis into the realm of the broadest philosophical principles, and investigates further some of the concepts already introduced in Religion in the Making, and Science and the Modern World.

While Parts III and IV contain the full technical elaboration of Whitehead's categoreal scheme, it should be noted that in his last years he expressed some doubts as to whether he had not sought a too precise elaboration in these chapters. Against that, however, one could quote his own statement in the first chapter of Part I: "Philosophy will not regain its proper status until the gradual elaboration of categoreal schemes, definitely stated at each stage of progress, is recognized as its proper objective."

Part I The Speculative Scheme

CHAPTER I *SPECULATIVE PHILOSOPHY*

SECTION I

This course of lectures is designed as an essay in Speculative Philosophy. Its first task must be to define 'speculative philosophy,' and to defend it as a method productive of important knowledge.

Speculative Philosophy is the endeavor to frame a coherent, logical, necessary system of general ideas in terms of which every element of our experience can be interpreted. By this notion of 'interpretation' I mean that everything of which we are conscious, as enjoyed, perceived, willed, or thought, shall have the character of a particular instance of the general scheme. Thus the philosophical scheme should be coherent, logical, and, in respect to its interpretation, applicable and adequate. Here 'applicable' means that some items of experience are thus interpretable, and 'adequate' means that there are no items incapable of such interpretation.

'Coherence,' as here employed, means that the fundamental ideas, in terms of which the scheme is developed, presuppose each other so that in isolation they are meaningless. This requirement does not mean that they are definable in terms of each other; it means that what is indefinable in one such notion cannot be abstracted from its relevance to the other notions. It is the ideal of speculative philosophy that its fundamental notions shall not seem capable of abstraction from each other. In other words, it is presupposed that no entity can be conceived in complete abstraction from the system of the universe, and that it is the business of speculative philosophy to exhibit this truth. This character is its coherence.

The term 'logical' has its ordinary meaning, including 'logical' consistency, or lack of contradiction, the definition of constructs in logical terms, the exemplification of general logical notions in specific instances, and the principles of inference. It will be observed that logical notions must themselves find their places in the scheme of philosophic notions.

It will also be noticed that this ideal of speculative philosophy

has its rational side and its empirical side. The rational side is expressed by the terms 'coherent' and 'logical.' The empirical side is expressed by the terms 'applicable' and 'adequate.' But the two sides are bound together by clearing away an ambiguity which remains in the previous explanation of the term 'adequate.' The adequacy of the scheme over every item does not mean adequacy over such items as happen to have been considered. It means that the texture of observed experience, as illustrating the philosophic scheme, is such that all related experience must exhibit the same texture. Thus the philosophic scheme should be 'necessary,' in the sense of bearing in itself its own warrant of universality throughout all experience, provided that we confine ourselves to that which communicates with immediate matter of fact. But what does not so communicate is unknowable, and the unknowable is unknown *; and so this universality defined by 'communication' can suffice.

This doctrine of necessity in universality means that there is an essence to the universe which forbids relationships beyond itself, as a violation of its rationality. Speculative philosophy seeks that essence.

SECTION II

Philosophers can never hope finally to formulate these metaphysical first principles. Weakness of insight and deficiencies of language stand in the way inexorably. Words and phrases must be stretched towards a generality foreign to their ordinary usage; and however such elements of language be stabilized as technicalities, they remain metaphors mutely appealing for an imaginative leap.

There is no first principle which is in itself unknowable, not to be captured by a flash of insight. But, putting aside the difficulties of language, deficiency in imaginative penetration forbids progress in any form other than that of an asymptotic approach to a scheme of principles, only definable in terms of the ideal which they should satisfy.

The difficulty has its seat in the empirical side of philosophy. Our datum is the actual world, including ourselves; and this actual world spreads itself for observation in the guise of the topic of our immediate experience. The elucidation of immediate experience is the

* This doctrine is a paradox. Indulging in a species of false modesty, 'cautious' philosophers undertake its definition.

sole justification for any thought; and the starting point for thought is the analytic observation of components of this experience. But we are not conscious of any clear-cut complete analysis of immediate experience, in terms of the various details which comprise its definiteness. We habitually observe by the method of difference. Sometimes we see an elephant, and sometimes we do not. The result is that an elephant, when present, is noticed. Facility of observation depends on the fact that the object observed is important when present, and sometimes is absent.

The metaphysical first principles can never fail of exemplification. We can never catch the actual world taking a holiday from their sway. Thus, for the discovery of metaphysics, the method of pinning down thought to the strict systematization of detailed discrimination, already effected by antecedent observation, breaks down. This collapse of the method of rigid empiricism is not confined to metaphysics. It occurs whenever we seek the larger generalities. In natural science this rigid method is the Baconian method of induction, a method which, if consistently pursued, would have left science where it found it. What Bacon omitted was the play of a free imagination, controlled by the requirements of coherence and logic. The true method of discovery is like the flight of an aeroplane. It starts from the ground of particular observation; it makes a flight in the thin air of imaginative generalization; and it again lands for renewed observation rendered acute by rational interpretation. The reason for the success of this method of imaginative rationalization is that, when the method of difference fails, factors which are constantly present may yet be observed under the influence of imaginative thought. Such thought supplies the differences which the direct observation lacks. It can even play with inconsistency; and can thus throw light on the consistent, and persistent, elements in experience by comparison with what in imagination is inconsistent with them. The negative judgment is the peak of mentality. But the conditions for the success of imaginative construction must be rigidly adhered to. In the first place, this construction must have its origin in the generalization of particular factors discerned in particular topics of human interest; for example, in physics, or in physiology, or in psychology, or in aesthetics, or in ethical beliefs, or in sociology, or in languages conceived as storehouses of human experience. In this way the prime requisite, that anyhow there shall be some important application, is secured. The

success of the imaginative experiment is always to be tested by the applicability of its results beyond the restricted locus from which it originated. In default of such extended application, a generalization started from physics, for example, remains merely an alternative expression of notions applicable to physics. The partially successful philosophic generalization will, if derived from physics, find applications in fields of experience beyond physics. It will enlighten observation in those remote fields, so that general principles can be discerned as in process of illustration, which in the absence of the imaginative generalization are obscured by their persistent exemplification.

Thus the first requisite is to proceed by the method of generalization so that certainly there is some application; and the test of some success is application beyond the immediate origin. In other words, some synoptic vision has been gained.

In this description of philosophic method, the term 'philosophic generalization' has meant 'the utilization of specific notions, applying to a restricted group of facts, for the divination of the generic notions which apply to all facts.'

In its use of this method natural science has shown a curious mixture of rationalism and irrationalism. Its prevalent tone of thought has been ardently rationalistic within its own borders, and dogmatically irrational beyond those borders. In practice such an attitude tends to become a dogmatic denial that there are any factors in the world not fully expressible in terms of its own primary notions devoid of further generalization. Such a denial is the self-denial of thought.

The second condition for the success of imaginative construction is unflinching pursuit of the two rationalistic ideals, coherence and logical perfection.

Logical perfection does not here require any detailed explanation. An example of its importance is afforded by the rôle of mathematics in the restricted field of natural science. The history of mathematics exhibits the generalization of special notions observed in particular instances. In any branches of mathematics, the notions presuppose each other. It is a remarkable characteristic of the history of thought that branches of mathematics developed under the pure imaginative impulse, thus controlled, finally receive their important application. Time may be wanted. Conic sections had to wait for eighteen hundred years. In more recent years, the theory of probability, the theory of tensors, the theory of matrices are cases in point.

The requirement of coherence is the great preservative of rationalistic sanity. But the validity of its criticism is not always admitted. If we consider philosophical controversies, we shall find that disputants tend to require coherence from their adversaries, and to grant dispensations to themselves. It has been remarked that a system of philosophy is never refuted; it is only abandoned. The reason is that logical contradictions, except as temporary slips of the mind—plentiful, though temporary—are the most gratuitous of errors; and usually they are trivial. Thus, after criticism, systems do not exhibit mere illogicalities. They suffer from inadequacy and incoherence. Failure to include some obvious elements of experience in the scope of the system is met by boldly denying the facts. Also while a philosophical system retains any charm of novelty, it enjoys a plenary indulgence for its failures in coherence. But after a system has acquired orthodoxy, and is taught with authority, it receives a sharper criticism. Its denials and its incoherences are found intolerable, and a reaction sets in.

Incoherence is the arbitrary disconnection of first principles. In modern philosophy Descartes' two kinds of substance, corporeal and mental, illustrate incoherence. There is, in Descartes' philosophy, no reason why there should not be a one-substance world, only corporeal, or a one-substance world, only mental. According to Descartes, a substantial individual 'requires nothing but itself in order to exist.' Thus this system makes a virtue of its incoherence. But on the other hand, the facts seem connected, while Descartes' system does not; for example, in the treatment of the body-mind problem. The Cartesian system obviously says something that is true. But its notions are too abstract to penetrate into the nature of things.

The attraction of Spinoza's philosophy lies in its modification of Descartes' position into greater coherence. He starts with one substance, *causa sui,* and considers its essential attributes and its individualized modes, i.e. the *'affectiones substantiae.'* The gap in the system is the arbitrary introduction of the 'modes.' And yet, a multiplicity of modes is a fixed requisite, if the scheme is to retain any direct relevance to the many occasions in the experienced world.

The philosophy of organism is closely allied to Spinoza's scheme of thought. But it differs by the abandonment of the subject-predicate forms of thought, so far as concerns the presupposition that this form is a direct embodiment of the most ultimate characterization of fact.

The result is that the 'substance-quality' concept is avoided; and that morphological description is replaced by description of dynamic process. Also Spinoza's 'modes' now become the sheer actualities; so that, though analysis of them increases our understanding, it does not lead us to the discovery of any higher grade of reality. The coherence, which the system seeks to preserve, is the discovery that the process, or concrescence, of any one actual entity involves the other actual entities among its components. In this way the obvious solidarity of the world receives its explanation.

In all philosophic theory there is an ultimate which is actual in virtue of its accidents. It is only then capable of characterization through its accidental embodiments, and apart from these accidents is devoid of actuality. In the philosophy of organism this ultimate is termed 'creativity'; and God is its primordial, non-temporal accident. In monistic philosophies, Spinoza's or absolute idealism, this ultimate is God, who is also equivalently termed 'The Absolute.' In such monistic schemes, the ultimate is illegitimately allowed a final, 'eminent' reality, beyond that ascribed to any of its accidents. In this general position the philosophy of organism seems to approximate more to some strains of Indian, or Chinese, thought, than to western Asiatic, or European, thought. One side makes process ultimate; the other side makes fact ultimate.

SECTION III

In its turn every philosophy will suffer a deposition. But the bundle of philosophic systems expresses a variety of general truths about the universe, awaiting co-ordination and assignment of their various spheres of validity. Such progress in co-ordination is provided by the advance of philosophy; and in this sense philosophy has advanced from Plato onwards. According to this account of the achievement of rationalism, the chief error in philosophy is overstatement. The aim at generalization is sound, but the estimate of success is exaggerated. There are two main forms of such overstatement. One form is what I have termed elsewhere,* the 'fallacy of misplaced concreteness.' This fallacy consists in neglecting the degree of abstraction involved when an actual entity is considered merely so far as it exemplifies certain categories of thought. There are aspects of actualities which are simply ignored so long as we restrict thought to these categories. Thus

* Cf. *Science and the Modern World,* Ch. III.

the success of a philosophy is to be measured by its comparative avoidance of this fallacy, when thought is restricted within its categories.

The other form of overstatement consists in a false estimate of logical procedure in respect to certainty, and in respect to premises. Philosophy has been haunted by the unfortunate notion that its method is dogmatically to indicate premises which are severally clear, distinct, and certain; and to erect upon those premises a deductive system of thought.

But the accurate expression of the final generalities is the goal of discussion and not its origin. Philosophy has been misled by the example of mathematics; and even in mathematics the statement of the ultimate logical principles is beset with difficulties, as yet insuperable.* The verification of a rationalistic scheme is to be sought in its general success, and not in the peculiar certainty, or initial clarity, of its first principles. In this connection the misuse of the *ex absurdo* argument has to be noted; much philosophical reasoning is vitiated by it. The only logical conclusion to be drawn, when a contradiction issues from a train of reasoning, is that at least one of the premises involved in the inference is false. It is rashly assumed without further question that the peccant premise can at once be located. In mathematics this assumption is often justified, and philosophers have been thereby misled. But in the absence of a well-defined categoreal scheme of entities, issuing in a satisfactory metaphysical system, every premise in a philosophical argument is under suspicion.

Philosophy will not regain its proper status until the gradual elaboration of categoreal schemes, definitely stated at each stage of progress, is recognized as its proper objective. There may be rival schemes, inconsistent among themselves; each with its own merits and its own failures. It will then be the purpose of research to conciliate the differences. Metaphysical categories are not dogmatic statements of the obvious; they are tentative formulations of the ultimate generalities.

If we consider any scheme of philosophic categories as one complex assertion, and apply to it the logician's alternative, true or false, the answer must be that the scheme is false. The same answer must be

* Cf. *Principia Mathematica*, by Bertrand Russell and A. N. Whitehead, Vol. I, Introduction and Introduction to the Second Edition. These introductory discussions are practically due to Russell, and in the second edition wholly so.

given to a like question respecting the existing formulated principles of any science.

The scheme is true with unformulated qualifications, exceptions, limitations, and new interpretations in terms of more general notions. We do not yet know how to recast the scheme into a logical truth. But the scheme is a matrix from which true propositions applicable to particular circumstances can be derived. We can at present only trust our trained instincts as to the discrimination of the circumstances in respect to which the scheme is valid.

The use of such a matrix is to argue from it boldly and with rigid logic. The scheme should therefore be stated with the utmost precision and definiteness, to allow of such argumentation. The conclusion of the argument should then be confronted with circumstances to which it should apply.

The primary advantage thus gained is that experience is not interrogated with the benumbing repression of common sense. The observation acquires an enhanced penetration by reason of the expectation evoked by the conclusion of the argument. The outcome from this procedure takes one of three forms: (i) the conclusion may agree with the observed facts; (ii) the conclusion may exhibit general agreement, with disagreement in detail; (iii) the conclusion may be in complete disagreement in the facts.

In the first case, the facts are known with more adequacy and the applicability of the system to the world has been elucidated. In the second case, criticisms of the observation of the facts and of the details of the scheme are both required. The history of thought shows that false interpretations of observed facts enter into the records of their observation. Thus both theory, and received notions as to fact, are in doubt. In the third case a fundamental reorganization of theory is required either by way of limiting it to some special province, or by way of entire abandonment of its main categories of thought.

After the initial basis of a rational life, with a civilized language, has been laid, all productive thought has proceeded either by the poetic insight of artists, or by the imaginative elaboration of schemes of thought capable of utilization as logical premises. In some measure or other, progress is always a transcendence of what is obvious.

Rationalism never shakes off its status of an experimental adventure. The combined influences of mathematics and religion, which have so greatly contributed to the rise of philosophy, have also had the

unfortunate effect of yoking it with static dogmatism. Rationalism is an adventure in the clarification of thought, progressive and never final. But it is an adventure in which even partial success has importance.

SECTION IV

The field of a special science is confined to one genus of facts, in the sense that no statements are made respecting facts which lie outside that genus. The very circumstance that a science has naturally arisen concerning a set of facts secures that facts of that type have definite relations among themselves which are very obvious to all mankind. The common obviousness of things arises when their explicit apprehension carries immediate importance for purposes of survival, or of enjoyment—that is to say, for purposes of 'being' and of 'well-being.' Elements in human experience, singled out in this way, are those elements concerning which language is copious and, within its limits, precise. The special sciences, therefore, deal with topics which lie open to easy inspection and are readily expressed by words.

The study of philosophy is a voyage towards the larger generalities. For this reason in the infancy of science, when the main stress lay in the discovery of the most general ideas usefully applicable to the subject-matter in question, philosophy was not sharply distinguished from science. To this day, a new science with any substantial novelty in its notions is considered to be in some way peculiarly philosophical. In their later stages, apart from occasional disturbances, most sciences accept without question the general notions in terms of which they develop. The main stress is laid on the adjustment and the direct verification of more special statements. In such periods scientists repudiate philosophy; Newton, justly satisfied with his physical principles, disclaimed metaphysics.

The fate of Newtonian physics warns us that there is a development in scientific first principles, and that their original forms can only be saved by interpretations of meaning and limitations of their field of application—interpretations and limitations unsuspected during the first period of successful employment. One chapter in the history of culture is concerned with the growth of generalities. In such a chapter it is seen that the older generalities, like the older hills, are worn down and diminished in height, surpassed by younger rivals.

Thus one aim of philosophy is to challenge the half-truths constituting the scientific first principles. The systematization of knowledge cannot be conducted in watertight compartments. All general truths condition each other; and the limits of their application cannot be adequately defined apart from their correlation by yet wider generalities. The criticism of principles must chiefly take the form of determining the proper meanings to be assigned to the fundamental notions of the various sciences, when these notions are considered in respect to their status relatively to each other. The determination of this status requires a generality transcending any special subject-matter.

If we may trust the Pythagorean tradition, the rise of European philosophy was largely promoted by the development of mathematics into a science of abstract generality. But in its subsequent development the method of philosophy has also been vitiated by the example of mathematics. The primary method of mathematics is deduction; the primary method of philosophy is descriptive generalization. Under the influence of mathematics, deduction has been foisted onto philosophy as its standard method, instead of taking its true place as an essential auxiliary mode of verification whereby to test the scope of generalities. This misapprehension of philosophic method has veiled the very considerable success of philosophy in providing generic notions which add lucidity to our apprehension of the facts of experience. The depositions of Plato, Aristotle, Thomas Aquinas, Descartes, Spinoza, Leibniz, Locke, Berkeley, Hume, Kant, Hegel, merely mean that ideas which these men introduced into the philosophic tradition must be construed with limitations, adaptations, and inversions, either unknown to them, or even explicitly repudiated by them. A new idea introduces a new alternative; and we are not less indebted to a thinker when we adopt the alternative which he discarded. Philosophy never reverts to its old position after the shock of a great philosopher.

SECTION V

Every science must devise its own instruments. The tool required for philosophy is language. Thus philosophy redesigns language in the same way that, in a physical science, preëxisting appliances are redesigned. It is exactly at this point that the appeal to facts is a difficult operation. This appeal is not solely to the expression of the facts in current verbal statements. The adequacy of such sentences is the

main question at issue. It is true that the general agreement of mankind as to experienced facts is best expressed in language. But the language of literature breaks down precisely at the task of expressing in explicit form the larger generalities—the very generalities which metaphysics seeks to express.

The point is that every proposition refers to a universe exhibiting some general systematic metaphysical character. Apart from this background, the separate entities which go to form the proposition, and the proposition as a whole, are without determinate character. Nothing has been defined, because every definite entity requires a systematic universe to supply its requisite status. Thus every proposition proposing a fact must, in its complete analysis, propose the general character of the universe required for that fact. There are no self-sustained facts, floating in nonentity. This doctrine, of the impossibility of tearing a proposition from its systematic context in the actual world, is a direct consequence of the fourth and the twentieth of the fundamental categoreal explanations which we shall be engaged in expanding and illustrating. A proposition can embody partial truth because it only demands a certain type of systematic environment, which is presupposed in its meaning. It does not refer to the universe in all its detail.

One practical aim of metaphysics is the accurate analysis of propositions; not merely of metaphysical propositions, but of quite ordinary propositions such as 'There is beef for dinner today,' and 'Socrates is mortal.' The one genus of facts which constitutes the field of some special science requires some common metaphysical presupposition respecting the universe. It is merely credulous to accept verbal phrases as adequate statements of propositions. The distinction between verbal phrases and complete propositions is one of the reasons why the logicians' rigid alternative, 'true or false,' is so largely irrelevant for the pursuit of knowledge.

The excessive trust in linguistic phrases has been the well-known reason vitiating so much of the philosophy and physics among the Greeks and among the medieval thinkers who continued the Greek traditions. For example John Stuart Mill writes: 'They (the Greeks) had great difficulty in distinguishing between things which their language confounded, or in putting mentally together things which it distinguished; and could hardly combine the objects in nature, into any classes but those which were made for them by the popular phrases

of their own country; or at least could not help fancying those classes to be natural, and all others arbitrary and artificial. Accordingly, scientific investigation among the Greek schools of speculation and their followers in the Middle Ages, was little more than a mere sifting and analysing of the notions attached to common language. They thought that by determining the meaning of words they could become acquainted with facts.' * Mill then proceeds to quote from Whewell† a paragraph illustrating the same weakness of Greek thought.

But neither Mill, nor Whewell, tracks this difficulty about language down to its sources. They both presuppose that language does enunciate well-defined propositions. This is quite untrue. Language is thoroughly indeterminate, by reason of the fact that every occurrence presupposes some systematic type of environment.

For example, the word 'Socrates,' referring to the philosopher, in one sentence may stand for an entity presupposing a more closely defined background than the word 'Socrates,' with the same reference, in another sentence. The word 'mortal' affords an analogous possibility. A precise language must await a completed metaphysical knowledge.

The technical language of philosophy represents attempts of various schools of thought to obtain explicit expression of general ideas presupposed by the facts of experience. It follows that any novelty in metaphysical doctrines exhibits some measure of disagreement with statements of the facts to be found in current philosophical literature. The extent of disagreement measures the extent of metaphysical divergence. It is, therefore, no valid criticism of one metaphysical school to point out that its doctrines do not follow from the verbal expression of the facts accepted by another school. The whole contention is that the doctrines in question supply a closer approach to fully expressed propositions.

The truth itself is nothing else than how the composite natures of the organic actualities of the world obtain adequate representation in the divine nature. Such representations compose the 'consequent nature' of God, which evolves in its relationship to the evolving world without derogation to the eternal completion of its primordial conceptual nature. In this way the 'ontological principle' is maintained—since there can be no determinate truth, correlating impartially the

* Cf. *Logic,* Book V, Ch. III.
† Cf. Whewell's *History of the Inductive Sciences.*

partial experiences of many actual entities, apart from one actual entity to which it can be referred. The reaction of the temporal world on the nature of God is considered subsequently in Part V: it is there termed 'the consequent nature of God.'

Whatever is found in 'practice' must lie within the scope of the metaphysical description. When the description fails to include the 'practice,' the metaphysics is inadequate and requires revision. There can be no appeal to practice to supplement metaphysics, so long as we remain contented with our metaphysical doctrines. Metaphysics is nothing but the description of the generalities which apply to all the details of practice.

No metaphysical system can hope entirely to satisfy these pragmatic tests. At the best such a system will remain only an approximation to the general truths which are sought. In particular, there are no precisely stated axiomatic certainties from which to start. There is not even the language in which to frame them. The only possible procedure is to start from verbal expressions which, when taken by themselves with the current meaning of their words, are ill-defined and ambiguous. These are not premises to be immediately reasoned from apart from elucidation by further discussion; they are endeavours to state general principles which will be exemplified in the subsequent description of the facts of experience. This subsequent elaboration should elucidate the meanings to be assigned to the words and phrases employed. Such meanings are incapable of accurate apprehension apart from a correspondingly accurate apprehension of the metaphysical background which the universe provides for them. But no language can be anything but elliptical, requiring a leap of the imagination to understand its meaning in its relevance to immediate experience. The position of metaphysics in the development of culture cannot be understood without remembering that no verbal statement is the adequate expression of a proposition.

An old established metaphysical system gains a false air of adequate precision from the fact that its words and phrases have passed into current literature. Thus propositions expressed in its language are more easily correlated to our flitting intuitions into metaphysical truth. When we trust these verbal statements and argue as though they adequately analysed meaning, we are led into difficulties which take the shape of negations of what in practice is presupposed. But when they are proposed as first principles they assume an unmerited air of sober

obviousness. Their defect is that the true propositions which they do express lose their fundamental character when subjected to adequate expression. For example consider the type of propositions such as 'The grass is green,' and 'The whale is big.' This subject-predicate form of statement seems so simple, leading straight to a metaphysical first principle; and yet in these examples it conceals such complex, diverse meanings.

SECTION VI

It has been an objection to speculative philosophy that it is over-ambitious. Rationalism, it is admitted, is the method by which advance is made within the limits of particular sciences. It is, however, held that this limited success must not encourage attempts to frame ambitious schemes expressive of the general nature of things.

One alleged justification of this criticism is ill-success: European thought is represented as littered with metaphysical systems, abandoned and unreconciled.

Such an assertion tacitly fastens upon philosophy the old dogmatic test. The same criterion would fasten ill-success upon science. We no more retain the physics of the seventeenth century than we do the Cartesian philosophy of that century. Yet within limits, both systems express important truths. Also we are beginning to understand the wider categories which define their limits of correct application. Of course, in that century, dogmatic views held sway; so that the validity both of the physical notions, and of the Cartesian notions, was misconceived. Mankind never quite knows what it is after. When we survey the history of thought, and likewise the history of practice, we find that one idea after another is tried out, its limitations defined, and its core of truth elicited. In application to the instinct for the intellectual adventures demanded by particular epochs, there is much truth in Augustine's rhetorical phrase, *Securus judicat orbis terrarum.* At the very least, men do what they can in the way of systematization, and in the event achieve something. The proper test is not that of finality, but of progress.

But the main objection, dating from the sixteenth century and receiving final expression from Francis Bacon, is the uselessness of philosophic speculation. The position taken by this objection is that we ought to describe detailed matter of fact, and elicit the laws with a generality strictly limited to the systematization of these described

details. General interpretation, it is held, has no bearing upon this procedure; and thus any system of general interpretation, be it true or false, remains intrinsically barren. Unfortunately for this objection, there are no brute, self-contained matters of fact, capable of being understood apart from interpretation as an element in a system. Whenever we attempt to express the matter of immediate experience, we find that its understanding leads us beyond itself, to its contemporaries, to its past, to its future, and to the universals in terms of which its definiteness is exhibited. But such universals, by their very character of universality, embody the potentiality of other facts with variant types of definiteness. Thus the understanding of the immediate brute fact requires its metaphysical interpretation as an item in a world with some systematic relation to it. When thought comes upon the scene, it finds the interpretations as matters of practice. Philosophy does not initiate interpretations. Its search for a rationalistic scheme is the search for more adequate criticism, and for more adequate justification, of the interpretations which we perforce employ. Our habitual experience is a complex of failure and success in the enterprise of interpretation. If we desire a record of uninterpreted experience, we must ask a stone to record its autobiography. Every scientific memoir in its record of the 'facts' is shot through and through with interpretation. The methodology of rational interpretation is the product of the fitful vagueness of consciousness. Elements which shine with immediate distinctness, in some circumstances, retire into penumbral shadow in other circumstances, and into black darkness on other occasions. And yet all occasions proclaim themselves as actualities within the flux of a solid world, demanding a unity of interpretation.

Philosophy is the self-correction by consciousness of its own initial excess of subjectivity. Each actual occasion contributes to the circumstances of its origin additional formative elements deepening its own peculiar individuality. Consciousness is only the last and greatest of such elements by which the selective character of the individual obscures the external totality from which it originates and which it embodies. An actual individual, of such higher grade, has truck with the totality of things by reason of its sheer actuality; but it has attained its individual depth of being by a selective emphasis limited to its own purposes. The task of philosophy is to recover the totality obscured by the selection. It replaces in rational experience what has

been submerged in the higher sensitive experience and has been sunk yet deeper by the initial operations of consciousness itself. The selectiveness of individual experience is moral so far as it conforms to the balance of importance disclosed in the rational vision; and conversely the conversion of the intellectual insight into an emotional force corrects the sensitive experience in the direction of morality. The correction is in proportion to the rationality of the insight.

Morality of outlook is inseparably conjoined with generality of outlook. The antithesis between the general good and the individual interest can be abolished only when the individual is such that its interest is the general good, thus exemplifying the loss of the minor intensities in order to find them again with finer composition in a wider sweep of interest.

Philosophy frees itself from the taint of ineffectiveness by its close relations with religion and with science, natural and sociological. It attains its chief importance by fusing the two, namely, religion and science, into one rational scheme of thought. Religion should connect the rational generality of philosophy with the emotions and purposes springing out of existence in a particular society, in a particular epoch, and conditioned by particular antecedents. Religion is the translation of general ideas into particular thoughts, particular emotions, and particular purposes; it is directed to the end of stretching individual interest beyond its self-defeating particularity. Philosophy finds religion, and modifies it; and conversely religion is among the data of experience which philosophy must weave into its own scheme. Religion is an ultimate craving to infuse into the insistent particularity of emotion that non-temporal generality which primarily belongs to conceptual thought alone. In the higher organisms the differences of tempo between the mere emotions and the conceptual experiences produce a life-tedium, unless this supreme fusion has been effected. The two sides of the organism require a reconciliation in which emotional experiences illustrate a conceptual justification, and conceptual experiences find an emotional illustration.

This demand for an intellectual justification of brute experience has also been the motive power in the advance of European science. In this sense scientific interest is only a variant form of religious interest. Any survey of the scientific devotion to 'truth,' as an ideal, will confirm this statement. There is, however, a grave divergence between science and religion in respect to the phases of individual

experience with which they are concerned. Religion is centered upon the harmony of rational thought with the sensitive reaction to the percepta from which experience originates. Science is concerned with the harmony of rational thought with the percepta themselves. When science deals with emotions, the emotions in question are percepta and not immediate passions—other people's emotion and not our own; at least our own in recollection, and not in immediacy. Religion deals with the formation of the experiencing subject; whereas science deals with the objects, which are the data forming the primary phase in this experience. The subject originates from, and amid, given conditions; science conciliates thought with this primary matter of fact; and religion conciliates the thought involved in the process with the sensitive reaction involved in that same process. The process is nothing else than the experiencing subject itself. In this explanation it is presumed that an experiencing subject is one occasion of sensitive reaction to an actual world. Science finds religious experiences among its percepta; and religion finds scientific concepts among the conceptual experiences to be fused with particular sensitive reactions.

The conclusion of this discussion is, first, the assertion of the old doctrine that breadth of thought reacting with intensity of sensitive experience stands out as an ultimate claim of existence; secondly, the assertion that empirically the development of self-justifying thoughts has been achieved by the complex process of generalizing from particular topics, of imaginatively schematizing the generalizations, and finally by renewed comparison of the imagined scheme with the direct experience to which it should apply.

There is no justification for checking generalization at any particular stage. Each phase of generalization exhibits its own peculiar simplicities which stand out just at that stage, and at no other stage. There are simplicities connected with the motion of a bar of steel which are obscured if we refuse to abstract from the individual molecules; and there are certain simplicities concerning the behaviour of men which are obscured if we refuse to abstract from the individual peculiarities of particular specimens. In the same way, there are certain general truths, about the actual things in the common world of activity, which will be obscured when attention is confined to some particular detailed mode of considering them. These general truths, involved in the meaning of every particular notion respecting the actions of things, are the subject matter for speculative philosophy.

Philosophy destroys its usefulness when it indulges in brilliant feats of explaining away. It is then trespassing with the wrong equipment upon the field of particular sciences. Its ultimate appeal is to the general consciousness of what in practice we experience. Whatever thread of presupposition characterizes social expression throughout the various epochs of rational society, must find its place in philosophic theory. Speculative boldness must be balanced by complete humility before logic, and before fact. It is a disease of philosophy when it is neither bold nor humble, but merely a reflection of the temperamental presuppositions of exceptional personalities.

Analogously, we do not trust any recasting of scientific theory depending upon a single performance of an aberrant experiment, unrepeated. The ultimate test is always widespread, recurrent experience; and the more general the rationalistic scheme, the more important is this final appeal.

The useful function of philosophy is to promote the most general systematization of civilized thought. There is a constant reaction between specialism and common sense. It is the part of the special sciences to modify common sense. Philosophy is the welding of imagination and common sense into a restraint upon specialists, and also into an enlargement of their imaginations. By providing the generic notions philosophy should make it easier to conceive the infinite variety of specific instances which rest unrealized in the womb of nature.

CHAPTER II *THE CATEGOREAL SCHEME*

SECTION I

This chapter contains an anticipatory sketch of the primary notions which constitute the philosophy of organism. The whole of the subsequent discussion in these lectures has the purpose of rendering this summary intelligible, and of showing that it embodies generic notions inevitably presupposed in our reflective experience—presupposed, but rarely expressed in explicit distinction. Four notions may be singled out from this summary, by reason of the fact that they involve some divergence from antecedent philosophical thought. These no-

tions are, that of an 'actual entity,' that of a 'prehension,' that of a 'nexus,' and that of the 'ontological principle.' Philosophical thought has made for itself difficulties by dealing exclusively in very abstract notions, such as those of mere awareness, mere private sensation, mere emotion, mere purpose, mere appearance, mere causation. These are the ghosts of the old 'faculties,' banished from psychology, but still haunting metaphysics. There can be no 'mere' togetherness of such abstractions. The result is that philosophical discussion is enmeshed in the fallacy of 'misplaced concreteness.' * In the three notions—actual entity, prehension, nexus—an endeavour has been made to base philosophical thought upon the most concrete elements in our experience.

'Actual entities'—also termed 'actual occasions'—are the final real things of which the world is made up. There is no going behind actual entities to find anything more real. They differ among themselves: God is an actual entity, and so is the most trivial puff of existence in far-off empty space. But, though there are gradations of importance, and diversities of function, yet in the principles which actuality exemplifies all are on the same level. The final facts are, all alike, actual entities; and these actual entities are drops of experience, complex and interdependent.

In its recurrence to the notion of a plurality of actual entities the philosophy of organism is through and through cartesian. The 'ontological principle' broadens and extends a general principle laid down by John Locke in his *Essay* (Bk. II, Ch. XXIII, Sec. 7), when he asserts that 'power' is 'a great part of our complex ideas of substances.' The notion of 'substance' is transformed into that of 'actual entity'; and the notion of 'power' is transformed into the principle that the reasons for things are always to be found in the composite nature of definite actual entities—in the nature of God for reasons of the highest absoluteness, and in the nature of definite temporal actual entities for reasons which refer to a particular environment. The ontological principle can be summarized as: no actual entity, then no reason.

Each actual entity is analysable in an indefinite number of ways. In some modes of analysis the component elements are more abstract than in other modes of analysis. The analysis of an actual entity into 'prehensions' is that mode of analysis which exhibits the most con-

* Cf. my *Science and the Modern World,* Ch. III.

crete elements in the nature of actual entities. This mode of analysis will be termed the 'division' of the actual entity in question. Each actual entity is 'divisible' in an indefinite number of ways, and each way of 'division' yields its definite quota of prehensions. A prehension reproduces in itself the general characteristics of an actual entity: it is referent to an external world, and in this sense will be said to have a 'vector character'; it involves emotion, and purpose, and valuation, and causation. In fact, any characteristic of an actual entity is reproduced in a prehension. It might have been a complete actuality; but, by reason of a certain incomplete partiality, a prehension is only a subordinate element in an actual entity. A reference to the complete actuality is required to give the reason why such a prehension is what it is in respect to its subjective form. This subjective form is determined by the subjective aim at further integration, so as to obtain the 'satisfaction' of the completed subject. In other words, final causation and atomism are interconnected philosophical principles.

With the purpose of obtaining a one-substance cosmology, 'prehensions' are a generalization from Descartes' mental 'cogitations,' and from Locke's 'ideas,' to express the most concrete mode of analysis applicable to every grade of individual actuality. Descartes and Locke maintained a two-substance ontology—Descartes explicitly, Locke by implication. Descartes, the mathematical physicist, emphasized his account of corporeal substance; and Locke, the physician and the sociologist, confined himself to an account of mental substance. The philosophy of organism, in its scheme for one type of actual entities, adopts the view that Locke's account of mental substance embodies, in a very special form, a more penetrating philosophic description than does Descartes' account of corporeal substance. Nevertheless, Descartes' account must find its place in the philosophic scheme. On the whole, this is the moral to be drawn from the *Monodology* of Leibniz. His monads are best conceived as generalizations of contemporary notions of mentality. The contemporary notions of physical bodies only enter into his philosophy subordinately and derivatively. The philosophy of organism endeavours to hold the balance more evenly. But it does start with a generalization of Locke's account of mental operations.

Actual entities involve each other by reason of their prehensions of each other. There are thus real individual facts of the togetherness of actual entities, which are real, individual, and particular,

in the same sense in which actual entities and the prehensions are real, individual, and particular. Any such particular fact of togetherness among actual entities is called a 'nexus' (plural form is written 'nexūs'). The ultimate facts of immediate actual experience are actual entities, prehensions, and nexūs. All else is, for our experience, derivative abstraction.

The explanatory purpose of philosophy is often misunderstood. Its business is to explain the emergence of the more abstract things from the more concrete things. It is a complete mistake to ask how concrete particular fact can be built up out of universals. The answer is, 'In no way.' The true philosophic question * is, How can concrete fact exhibit entities abstract from itself and yet participated in by its own nature?

In other words, philosophy is explanatory of abstraction, and not of concreteness. It is by reason of their instinctive grasp of this ultimate truth that, in spite of much association with arbitrary fancifulness and atavistic mysticism, types of Platonic philosophy retain their abiding appeal; they seek the forms in the facts. Each fact is more than its forms, and each form 'participates' throughout the world of facts. The definiteness of fact is due to its forms; but the individual fact is a creature, and creativity is the ultimate behind all forms, inexplicable by forms, and conditioned by its creatures.

SECTION II

The Categories

I. The Category of the Ultimate.
II. Categories of Existence.
III. Categories of Explanation.
IV. Categoreal Obligations.

It is the purpose of the discussion in these lectures to make clear the meaning of these categories, their applicability, and their adequacy. The course of the discussion will disclose how very far they are from satisfying this ideal.

Every entity should be a specific instance of one category of existence, every explanation should be a specific instance of categories of explanation, and every obligation should be a specific instance of

* In this connection I may refer to the second chapter of my book *The Principle of Relativity* (Cambridge University, 1922).

categoreal obligations. The category of the Ultimate expresses the general principle presupposed in the three more special categories.

The Category of the Ultimate

'Creativity,' 'many,' 'one' are the ultimate notions involved in the meaning of the synonymous terms 'thing,' 'being,' 'entity.' These three notions complete the Category of the Ultimate and are presupposed in all the more special categories.

The term 'one' does not stand for 'the integral number *one*,' which is a complex special notion. It stands for the general idea underlying alike the indefinite article *'a* or *an,'* and the definite article *'the,'* and the demonstratives *'this* or *that,'* and the relatives *'which* or *what* or *how*.' It stands for the singularity of an entity. The term 'many' presupposes the term 'one,' and the term 'one' presupposes the term 'many.' The term 'many' conveys the notion of 'disjunctive diversity'; this notion is an essential element in the concept of 'being.' There are many 'beings' in disjunctive diversity.

'Creativity' is the universal of universals characterizing ultimate matter of fact. It is that ultimate principle by which the many, which are the universe disjunctively, become the one actual occasion, which is the universe conjunctively. It lies in the nature of things that the many enter into complex unity.

'Creativity' is the principle of *novelty*. An actual occasion is a novel entity diverse from any entity in the 'many' which it unifies. Thus 'creativity' introduces novelty into the content of the many, which are the universe disjunctively. The 'creative advance' is the application of this ultimate principle of creativity to each novel situation which it originates.

'Together' is a generic term covering the various special ways in which various sorts of entities are 'together' in any one actual occasion. Thus 'together' presupposes the notions 'creativity,' 'many,' 'one,' 'identity' and 'diversity.' The ultimate metaphysical principle is the advance from disjunction to conjunction, creating a novel entity other than the entities given in disjunction. The novel entity is at once the togetherness of the 'many' which it finds, and also it is one among the disjunctive 'many' which it leaves; it is a novel entity, disjunctively among the many entities which it synthesizes. The many become one, and are increased by one. In their natures, entities are disjunctively 'many' in process of passage into conjunctive unity. This Cate-

gory of the Ultimate replaces Aristotle's category of 'primary substance.'

Thus the 'production of novel togetherness' is the ultimate notion embodied in the term 'concrescence.' These ultimate notions of 'production of novelty' and of 'concrete togetherness' are inexplicable either in terms of higher universals or in terms of the components participating in the concrescence. The analysis of the components abstracts from the concrescence. The sole appeal is to intuition.

The Categories of Existence

There are eight Categories of Existence:

(i) Actual Entities (also termed Actual Occasions), *or* Final Realities, or *Rēs Verae*.

(ii) Prehensions, *or* Concrete Facts of Relatedness.

(iii) Nexūs (plural of Nexus), *or* Public Matters of Fact.

(iv) Subjective Forms, *or* Private Matters of Fact.

(v) Eternal Objects, *or* Pure Potentials for the Specific Determination of Fact, *or* Forms of Definiteness.

(vi) Propositions, *or* Matters of Fact in Potential Determination, *or* Impure Potentials for the Specific Determination of Matters of Fact, *or* Theories.

(vii) Multiplicities, *or* Pure Disjunctions of Diverse Entities.

(viii) Contrasts, *or* Modes of Synthesis of Entities in one Prehension.

Among these eight categories of existence, actual entities and eternal objects stand out with a certain extreme finality. The other types of existence have a certain intermediate character. The eighth category includes an indefinite progression of categories, as we proceed from 'contrasts' to 'contrasts of contrasts,' and on indefinitely to higher grades of contrasts.

The Categories of Explanation

There are twenty-seven Categories of Explanation:

(i) That the actual world is a process, and that the process is the becoming of actual entities. Thus actual entities are creatures; they are also termed 'actual occasions.'

(ii) That in the becoming of an actual entity, the *potential* unit of many entities—actual and non-actual—acquires the *real* unity of

the one actual entity; so that the actual entity is the real concrescence of many potentials.

(iii) That in the becoming of an actual entity, novel prehensions, nexūs, subjective forms, propositions, multiplicities, and contrasts, also become; but there are no novel eternal objects.

(iv) That the potentiality for being an element in a real concrescence of many entities into one actuality, is the one general metaphysical character attaching to all entities, actual and non-actual; and that every item in its universe is involved in each concrescence. In other words, it belongs to the nature of a 'being' that it is a potential for every 'becoming.' This is the 'principle of relativity.'

(v) That no two actual entities originate from an identical universe; though the difference between the two universes only consists in some actual entities, included in one and not in the other, and in the subordinate entities which each actual entity introduces into the world. The eternal objects are the same for all actual entities. The nexus of actual entities in the universe correlate to a concrescence, is termed 'the actual world' correlate to that concrescence.

(vi) That each entity in the universe of a given concrescence *can,* so far as its own nature is concerned, be implicated in that concrescence in one or other of many modes; but *in fact* it is implicated only in *one* mode: that the particular mode of implication is only rendered fully determinate by that concrescence, though it is conditioned by the correlate universe. This indetermination, rendered determinate in the real concrescence, is the meaning of 'potentiality.' It is a *conditioned* indetermination, and is therefore called a '*real* potentiality.'

(vii) That an eternal object can be described only in terms of its potentiality for 'ingression' into the becoming of actual entities; and that its analysis only discloses other eternal objects. It is a pure potential. The term 'ingression' refers to the particular mode in which the potentiality of an eternal object is realized in a particular actual entity, contributing to the definiteness of that actual entity.

(viii) That two descriptions are required for an actual entity: (a) one which is analytical of its potentiality for 'objectification' in the becoming of other actual entities, and (b) another which is analytical of the process which constitutes its own becoming.

The term 'objectification' refers to the particular mode in which the potentiality of one actual entity is realized in another actual entity.

(ix) That *how* an actual entity *becomes* constitutes *what* that

actual entity *is;* so that the two descriptions of an actual entity are not independent. Its 'being' is constituted by its 'becoming.' This is the 'principle of process.'

(x) That the first analysis of an actual entity, into its most concrete elements, discloses it to be a concrescence of prehensions, which have originated in its process of becoming. All further analysis is an analysis of prehensions. Analysis in terms of prehensions is termed 'division.'

(xi) That every prehension consists of three factors: (a) the 'subject' which is prehending, namely, the actual entity in which that prehension is a concrete element; (b) the 'datum' which is prehended; (c) the 'subjective form' which is *how* that subject prehends that datum.

Prehensions of actual entities—i.e., prehensions whose data involve actual entities—are termed 'physical prehensions'; and prehensions of eternal objects are termed 'conceptual prehensions.' Consciousness is not necessarily involved in the subjective forms of either type of prehension.

(xii) That there are two species of prehensions: (a) 'positive prehensions' which are termed 'feelings,' and (b) 'negative prehensions' which are said to 'eliminate from feeling.' Negative prehensions also have subjective forms. A negative prehension holds its datum as inoperative in the progressive concrescence of prehensions constituting the unity of the subject.

(xiii) That there are many species of subjective forms, such as emotions, valuations, purposes, adversions, aversions, consciousness, etc.

(xiv) That a nexus is a set of actual entities in the unity of the relatedness constituted by their prehensions of each other, or—what is the same thing conversely expressed—constituted by their objectifications in each other.

(xv) That a proposition is the unity of certain actual entities in their potentiality for forming a nexus, with its potential relatedness partially defined by certain eternal objects which have the unity of one complex eternal object. The actual entities involved are termed the 'logical subjects,' the complex eternal object is the 'predicate.'

(xvi) That a multiplicity consists of many entities, and its unity is constituted by the fact that all its constituent entities severally satisfy at least one condition which no other entity satisfies.

Every statement about a particular multiplicity can be expressed as

a statement referent either (a) to *all* its members severally, or (b) to an indefinite *some* of its members severally, or (c) as a denial of one of these statements. Any statement, incapable of being expressed in this form, is not a statement about a multiplicity, though it may be a statement about an entity closely allied to some multiplicity, i.e., systematically allied to each member of some multiplicity.

(xvii) That whatever is a datum for a feeling has a unity *as felt*. Thus the many components of a complex datum have a unity: this unity is a 'contrast' of entities. In a sense this means that there are an endless number of categories of existence, since the synthesis of entities into a contrast in general produces a new existential type. For example, a proposition is, in a sense, a 'contrast.' For the practical purposes of 'human understanding,' it is sufficient to consider a few basic types of existence, and to lump the more derivative types together under the heading of 'contrasts.' The most important of such 'contrasts' is the 'affirmation-negation' contrast in which a proposition and a nexus obtain synthesis in one datum, the members of the nexus being the 'logical subjects' of the proposition.

(xviii) That every condition to which the process of becoming conforms in any particular instance, has its reason *either* in the character of some actual entity in the actual world of that concrescence, *or* in the character of the subject which is in process of concrescence. This category of explanation is termed the 'ontological principle.' It could also be termed the 'principle of efficient, and final, causation.' This ontological principle means that actual entities are the only *reasons;* so that to search for a *reason* is to search for one or more actual entities. It follows that any condition to be satisfied by one actual entity in its process expresses a fact either about the 'real internal constitutions' of some other actual entities, or about the 'subjective aim' conditioning that process.

The phrase 'real internal constitution' is to be found in Locke's *Essay Concerning Human Understanding* (III, III, 15: 'And thus the real internal (but generally in substances unknown) constitution of things, whereon their discoverable qualities depend, may be called their "essence." ' Also the terms 'prehension' and 'feeling' are to be compared with the various significations of Locke's term 'idea.' But they are adopted as more general and more neutral terms than 'idea' as used by Locke, who seems to restrict them to *conscious*

mentality. Also the ordinary logical account of 'propositions' expresses only a restricted aspect of their rôle in the universe, namely, when they are the data of feelings whose subjective forms are those of judgments. It is an essential doctrine in the philosophy of organism that the primary function of a proposition is to be relevant as a lure for feeling. For example, some propositions are the data of feelings with subjective forms such as to constitute those feelings to be the enjoyment of a joke. Other propositions are felt with feelings whose subjective forms are horror, disgust, or indignation. The 'subjective aim,' which controls the becoming of a subject, is that subject feeling a proposition with the subjective form of purpose to realize it in that process of self-creation.

(xix) That the fundamental types of entities are actual entities, and eternal objects; and that the other types of entities only express how all entities of the two fundamental types are in community with each other, in the actual world.

(xx) That to 'function' means to contribute determination to the actual entities in the nexus of some actual world. Thus the determinateness and self-identity of one entity cannot be abstracted from the community of the diverse functionings of all entities. 'Determination' is analysable into 'definiteness' and 'position,' where 'definiteness' is the illustration of select eternal objects, and 'position' is relative status in a nexus of actual entities.

(xxi) An entity is actual, when it has significance for itself. By this it is meant that an actual entity functions in respect to its own determination. Thus an actual entity combines self-identity with self-diversity.

(xxii) That an actual entity by functioning in respect to itself plays diverse rôles in self-formation without losing its self-identity. It is self-creative; and in its process of creation transforms its diversity of rôles into one coherent rôle. Thus 'becoming' is the transformation of incoherence into coherence, and in each particular instance ceases with this attainment.

(xxiii) That this self-functioning is the real internal constitution of an actual entity. It is the 'immediacy' of the actual entity. An actual entity is called the 'subject' of its own immediacy.

(xxiv) The functioning of one actual entity in the self-creation of another actual entity is the 'objectification' of the former for the

latter actual entity. The functioning of an eternal object in the self-creation of an actual entity is the 'ingression' of the eternal object in the actual entity.

(xxv) The final phase in the process of concrescence, constituting an actual entity, is one complex, fully determinate feeling. This final phase is termed the 'satisfaction.' It is fully determinate (a) as to its genesis, (b) as to its objective character for the transcendent creativity, and (c) as to its prehension—positive or negative—of every item in its universe.

(xxvi) Each element in the genetic process of an actual entity has one self-consistent function, however complex, in the final satisfaction.

(xxvii) In a process of concrescence, there is a succession of phases in which new prehensions arise by integration of prehensions in antecedent phases. In these integrations 'feelings' contribute their 'subjective forms' and their 'data' to the formation of novel integral prehensions; but 'negative prehensions' contribute only their 'subjective forms.' The process continues till all prehensions are components in the one determinate integral satisfaction.

SECTION III

There are nine Categoreal Obligations:

(i) *The Category of Subjective Unity*. The many feelings which belong to an incomplete phase in the process of an actual entity, though unintegrated by reason of the incompleteness of the phase, are compatible for integration by reason of the unity of their subject.

(ii) *The Category of Objective Identity*. There can be no duplication of any element in the objective datum of the 'satisfaction' of an actual entity, so far as concerns the function of that element in the 'satisfaction.'

Here, as always, the term 'satisfaction' means the one complex fully determinate feeling which is the completed phase in the process. This category expresses that each element has one self-consistent function, however complex. Logic is the general analysis of self-consistency.

(iii) *The Category of Objective Diversity*. There can be no 'coalescence' of diverse elements in the objective datum of an actual entity, so far as concerns the functions of those elements in that satisfaction.

'Coalescence' here means the notion of diverse elements exercising an absolute identity of function, devoid of the contrasts inherent in their diversities.

(iv) *The Category of Conceptual Valuation.* From each physical feeling there is the derivation of a purely conceptual feeling whose datum is the eternal object determinant of the definiteness of the actual entity, or of the nexus, physically felt.

(v) *The Category of Conceptual Reversion.* There is secondary origination of conceptual feelings with data which are partially identical with, and partially diverse from, the eternal objects forming the data in the first phase of the mental pole. The diversity is a relevant diversity determined by the subjective aim.

Note that category (iv) concerns conceptual reproduction of physical feeling, and category (v) concerns conceptual diversity from physical feeling.

(vi) *The Category of Transmutation.* When (in accordance with category [iv], or with categories [iv] and [v]) one and the same conceptual feeling is derived impartially by a prehending subject from its analogous, simple, physical feelings of various actual entities in its actual world, then, in a subsequent phase of integration of these simple physical feelings together with the derivate conceptual feeling, the prehending subject may transmute the *datum* of this conceptual feeling into a characteristic of some *nexus* containing those prehended actual entities among its members, or of some part of that nexus. In this way the nexus (or its part), thus characterized, is the objective datum of a feeling entertained by this prehending subject.

It is evident that the complete datum of the transmuted feeling is a contrast, namely, 'the nexus, as one, in contrast with the eternal object.' This type of contrast is one of the meanings of the notion 'qualification of physical substance by quality.'

This category is the way in which the philosophy of organism, which is an atomic theory of actuality, meets a perplexity which is inherent in all monadic cosmologies. Leibniz in his *Monadology* meets the same difficulty by a theory of 'confused' perception. But he fails to make clear how 'confusion' originates.

(vii) *The Category of Subjective Harmony.* The valuations of conceptual feelings are mutually determined by the adaptation of those feelings to be contrasted elements congruent with the subjective aim.

Category (i) and category (vii) jointly express a pre-established

harmony in the process of concrescence of any one subject. Category (i) has to do with data felt, and category (vii) with the subjective forms of the conceptual feelings. This pre-established harmony is an outcome of the fact that no prehension can be considered in abstraction from its subject, although it originates in the process creative of its subject.

(viii) *The Category of Subjective Intensity*. The subjective aim, whereby there is origination of conceptual feeling, is at intensity of feeling (α) in the immediate subject, and (β) in the *relevant* future.

This double aim—at the *immediate* present and the *relevant* future —is less divided than appears on the surface. For the determination of the *relevant* future, and the *anticipatory* feeling respecting provision for its grade of intensity, are elements affecting the immediate complex of feeling. The greater part of mortality hinges on the determination of relevance in the future. The relevant future consists of those elements in the anticipated future which are felt with effective intensity by the present subject by reason of the real potentiality for them to be derived from itself.

(ix) *The Category of Freedom and Determination*. The concrescence of each individual actual entity is internally determined and is externally free.

This category can be condensed into the formula, that in each concrescence whatever is determinable is determined, but that there is always a remainder for the decision of the subject-superject of that concrescence. This subject-superject is the universe in that synthesis, and beyond it there is nonentity. This final decision is the reaction of the unity of the whole to its own internal determination. This reaction is the final modification of emotion, appreciation, and purpose. But the decision of the whole arises out of the determination of the parts, so as to be strictly relevant to it.

SECTION IV

The whole of the subsequent discussion in the subsequent parts either leads up to these categories (of the four types) or is explanatory of them, or is considering our experience of the world in the light of these categories. But a few preliminary notes may be useful.

It follows from the fourth category of explanation that the notion of 'complete abstraction' is self-contradictory. For you cannot abstract

the universe from any entity, actual or non-actual, so as to consider that entity in complete isolation. Whenever we think of some entity, we are asking, What is it fit for here? In a sense, every entity pervades the whole world; for this question has a definite answer for each entity in respect to any actual entity or any nexus of actual entities.

It follows from the first category of explanation that 'becoming' is a creative advance into novelty. It is for this reason that the meaning of the phrase 'the actual world' is relative to the becoming of a definite actual entity which is both novel and actual, relatively to that meaning, and to no other meaning of that phrase. Thus, conversely, each actual entity corresponds to a meaning of 'the actual world' peculiar to itself. This point is dealt with more generally in categories of explanation (iii) and (v). An actual world is a nexus; and the actual world of one actual entity sinks to the level of a subordinate nexus in actual worlds beyond that actual entity.

The first, the fourth, the eighteenth, and twenty-seventh categories state different aspects of one and the same general metaphysical truth. The first category states the doctrine in a general way: that every ultimate actuality embodies in its own essence what Alexander * terms 'a principle of unrest,' namely, its becoming. The fourth category applies this doctrine to the very notion of an 'entity.' It asserts that the notion of an 'entity' means 'an element contributory to the process of becoming.' We have in this category the utmost generalization of the notion of 'relativity.' The eighteenth category asserts that the obligations imposed on the becoming of any particular actual entity arise from the constitutions of other actual entities.

The four categories of explanation, (x) to (xiii), constitute the repudiation of the notion of vacuous actuality, which haunts realistic philosophy. The term 'vacuous actuality' here means the notion of a *res vera* devoid of subjective immediacy. This repudiation is fundamental for the organic philosophy (cf. Part II, Ch. VII, 'The Subjectivist Principle'). The notion of 'vacuous actuality' is very closely allied to the notion of the 'inherence of quality in substance.' Both notions—in their misapplication as fundamental metaphysical categories—find their chief support in a misunderstanding of the true analysis of 'presentational immediacy' (cf. Part II, Ch. II, Secs. I and V).

* Cf. "Artistic Creation and Cosmic Creation," *Proc. Brit. Acad.*, 1927, Vol. XIII.

It is fundamental to the metaphysical doctrine of the philosophy of organism, that the notion of an actual entity as the unchanging subject of change is completely abandoned. An actual entity is at once the subject experiencing and the superject of its experiences. It is subject-superject, and neither half of this description can for a moment be lost sight of. The term 'subject' will be mostly employed when the actual entity is considered in respect to its own real internal constitution. But 'subject' is always to be construed as an abbreviation of 'subject-superject.'

The ancient doctrine that 'no one crosses the same river twice' is extended. No thinker thinks twice; and, to put the matter more generally, no subject experiences twice. This is what Locke ought to have meant by his doctrine of time as a 'perpetual perishing.'

This repudiation directly contradicts Kant's 'First Analogy of Experience' in either of its ways of phrasing (1st or 2d edition). In the philosophy of organism it is not 'substance' which is permanent, but 'form.' Forms suffer changing relations; actual entities 'perpetually perish' subjectively, but are immortal objectively. Actuality in perishing acquires objectivity, while it loses subjective immediacy. It loses the final causation which is its internal principle of unrest, and it acquires efficient causation whereby it is a ground of obligation characterizing the creativity.

Actual occasions in their 'formal' constitutions are devoid of all indetermination. Potentiality has passed into realization. They are complete and determinate matter of fact, devoid of all indecision. They form the ground of obligation. But eternal objects, and propositions, and some more complex sorts of contrasts, involve in their own natures indecision. They are, like all entities, potentials for the process of becoming. Their ingression expresses the *definiteness* of the actuality in question. But their own natures do not in themselves disclose in what actual entities this potentiality of ingression is realized. Thus they involve indetermination in a sense more complete than do the former set.

A multiplicity merely enters into process through its individual members. The only statements to be made about a multiplicity express how its individual members enter into the process of the actual world. Any entity which enters into process in this way belongs to the multiplicity, and no other entities do belong to it. It can be treated as a unity for this purpose, and this purpose only. For example, each of the six kinds of entities just mentioned are multiplicities (i.e., not the

individual entities of the kinds, but the collective kinds of the entities). A multiplicity has solely a disjunctive relationship to the actual world. The 'universe' comprising the absolutely initial data for an actual entity is a multiplicity. The treatment of a multiplicity as though it had the unity belonging to an entity of any one of the other six kinds produces logical errors. Whenever the word 'entity' is used, it is to be assumed, unless otherwise stated, that it refers to an entity of one of the six kinds, and *not* to a multiplicity.

There is no emergent evolution concerned with a multiplicity, so that every statement about a multiplicity is a disjunctive statement about its individual members. Entities of any of the first six kinds, and generic contrasts, will be called 'proper entities.'

In its development the subsequent discussion of the philosophy of organism is governed by the belief that the subject-predicate form of proposition is concerned with high abstractions, except in its application to subjective forms. This sort of abstraction, apart from this exception, is rarely relevant to metaphysical description. The dominance of Aristotelian logic from the late classical period onwards has imposed on metaphysical thought the categories naturally derivative from its phraseology. This dominance of his logic does not seem to have been characteristic of Aristotle's own metaphysical speculations. The divergencies, such as they are, in these lectures from other philosophical doctrines mostly depend upon the fact that many philosophers, who in their explicit statements criticize the Aristotelian notion of 'substance,' yet implicitly throughout their discussions presuppose that the 'subject-predicate' form of proposition embodies the finally adequate mode of statement about the actual world. The evil produced by the Aristotelian 'primary substance' is exactly this habit of metaphysical emphasis upon the 'subject-predicate' form of proposition.

CHAPTER III *SOME DERIVATIVE NOTIONS*

SECTION I

The primordial created fact is the unconditioned conceptual valuation of the entire multiplicity of eternal objects. This is the 'primordial nature' of God. By reason of this complete valuation, the objectifica-

tion of God in each derivate actual entity results in a graduation of the relevance of eternal objects to the concrescent phases of that derivate occasion. There will be additional ground of relevance for select eternal objects by reason of their ingression into derivate actual entities belonging to the actual world of the concrescent occasion in question. But whether or no this be the case, there is always the definite relevance derived from God. Apart from God, eternal objects unrealized in the actual world would be relatively non-existent for the concrescence in question. For effective relevance requires agency of comparison, and agency belongs exclusively to actual occasions. This divine ordering is itself matter of fact, thereby conditioning creativity. Thus possibility which transcends realized temporal matter of fact has a real relevance to the creative advance. God is the primordial creature; but the description of his nature is not exhausted by this conceptual side of it. His 'consequent nature' results from his physical prehensions of the derivative actual entities (cf. Part V).

'Creativity' is another rendering of the Aristotelian 'matter,' and of the modern 'neutral stuff.' But it is divested of the notion of passive receptivity, either of 'form,' or of external relations; it is the pure notion of the activity conditioned by the objective immortality of the actual world—a world which is never the same twice, though always with the stable element of divine ordering. Creativity is without a character of its own in exactly the same sense in which the Aristotelian 'matter' is without a character of its own. It is that ultimate notion of the highest generality at the base of actuality. It cannot be characterized, because all characters are more special than itself. But creativity is always found under conditions, and described as conditioned. The non-temporal act of all-inclusive unfettered valuation is at once a creature of creativity and a condition for creativity. It shares this double character with all creatures. By reason of its character as a creature, always in concrescence and never in the past, it receives a reaction from the world; this reaction is its consequent nature. It is here termed 'God'; because the contemplation of our natures, as enjoying real feelings derived from the timeless source of all order, acquires that 'subjective form' of refreshment and companionship at which religions aim.

This function of creatures, that they constitute the shifting char-

acter of creativity, is here termed the 'objective immortality' of actual entities. Thus God has objective immortality in respect to his primordial nature and his consequent nature. The objective immortality of his consequent nature is considered later (cf. Part V); we are now concerned with his primordial nature.

God's immanence in the world in respect to his primordial nature is an urge towards the future based upon an appetite in the present. Appetition is at once the conceptual valuation of an immediate physical feeling combined with the urge towards realization of the datum conceptually prehended. For example 'thirst' is an immediate physical feeling integrated with the conceptual prehension of its quenching.

Appetition * is immediate matter of fact including in itself a principle of unrest, involving realization of what is not and may be. The immediate occasion thereby conditions creativity so as to procure, in the future, physical realization of its mental pole, according to the various valuations inherent in its various conceptual prehensions. All physical experience is accompanied by an appetite for, or against, its continuance: an example is the appetition of self-preservation. But the origination of the novel conceptual prehension has, more especially, to be accounted for. Thirst is an appetite towards a difference—towards something relevant, something largely identical, but something with a definite novelty. This is an example at a low level which shows the germ of a free imagination.

In what sense can unrealized abstract form be relevant? What is its basis of relevance? 'Relevance' must express some real fact of togetherness among forms. The ontological principle can be expressed as: All real togetherness is togetherness in the formal constitution of an actuality. So if there be a relevance of what in the temporal world is unrealized, the relevance must express a fact of togetherness in the formal constitution of a non-temporal actuality. But by the principle of relativity there can only be one non-derivative actuality, unbounded by its prehensions of an actual world. Such a primordial superject of creativity achieves, in its unity of satisfaction, the complete conceptual valuation of all eternal objects. This is the ultimate, basic adjustment of the togetherness of eternal objects on which creative order depends. It is the conceptual adjustment of all appetites

* Cf. Leibniz's *Monadology*.

in the form of aversions and adversions. It constitutes the meaning of relevance. Its status as an actual efficient fact is recognized by terming it the 'primordial nature of God.'

The word 'appetition' illustrates a danger which lurks in technical terms. This same danger is also illustrated in the psychology derived from Freud. The mental poles of actualities contribute various grades of complex feelings to the actualities including them as factors. The basic operations of mentality are 'conceptual prehensions.' These are the only operations of 'pure' mentality. All other mental operations are 'impure,' in the sense that they involve integrations of conceptual prehensions with the physical prehensions of the physical pole. Since 'impurity' in prehension refers to the prehension arising out of the integration of 'pure' physical prehensions with 'pure' mental prehensions, it follows that an impure mental prehension is also an 'impure' physical prehension and conversely. Thus the term 'impure' applied to a prehension has a perfectly definite meaning; and does not require the terms 'mental' or 'physical', except for the direction of attention in the discussion concerned.

The technical term 'conceptual prehension' is entirely neutral, devoid of all suggestiveness. But such terms present great difficulties to the understanding, by reason of the fact that they suggest no particular exemplifications. Accordingly, we seek equivalent terms which have about them the suggestiveness of familiar fact. We have chosen the term 'appetition,' which suggests exemplifications in our own experience, also in lower terms of life such as insects and vegetables. But even in human experience 'appetition' suggests a degrading notion of this basic activity in its more intense operations. We are closely concerned with what Bergson calls 'intuition'—with some differences however. Bergson's intuition is an 'impure' operation; it is an integral feeling derived from the synthesis of the conceptual prehension with the physical prehension from which it has been derived according to the 'category of conceptual reproduction' (Categoreal Obligation IV). It seems that Bergson's term 'intuition' has the same meaning as 'physical purpose' in Part III of these lectures. Also Bergson's 'intuition' seems to abstract from the subjective form of emotion and purpose. This subjective form is an essential element in the notion of 'conceptual prehension,' as indeed in that of any prehension. It is an essential element in 'physical purpose' (cf. Part III). If we consider these 'pure' mental operations in their most intense operations,

we should choose the term 'vision.' A conceptual prehension is a direct vision of some possibility of good or evil—of some possibility as to how actualities *may* be *definite*. There is no reference to particular actualities, or to any particular actual world. The phrase 'of good or of evil' has been added to include a reference to the subjective form; the mere word 'vision' abstracts from this factor in a conceptual prehension. If we say that God's primordial nature is a completeness of 'appetition,' we give due weight to the subjective form—at a cost. If we say that God's primordial nature is 'intuition,' we suggest mentality which is 'impure' by reason of synthesis with physical prehension. If we say that God's primordial nature is 'vision,' we suggest a maimed view of the subjective form, divesting it of yearning after concrete fact—no particular facts, but after *some* actuality. There is deficiency in God's primordial nature which the term 'vision' obscures. One advantage of the term 'vision' is that it connects this doctrine of God more closely with philosophical tradition. 'Envisagement' is perhaps a safer term than 'vision.' To sum up: God's 'primordial nature' is abstracted from his commerce with 'particulars,' and is therefore devoid of those 'impure' intellectual cogitations which involve propositions (cf. Part III). It is God in abstraction, alone with himself. As such it is a mere factor in God, deficient in actuality.

SECTION II

The notions of 'social order' and of 'personal order' cannot be omitted from this preliminary sketch. A 'society,' in the sense in which that term is here used, is a nexus with social order; and an 'enduring object,' or 'enduring creature,' is a society whose social order has taken the special form of 'personal order.'

A nexus enjoys 'social order' where (i) there is a common element of form illustrated in the definiteness of each of its included actual entities, and (ii) this common element of form arises in each member of the nexus by reason of the conditions imposed upon it by its prehensions of some other members of the nexus, and (iii) these prehensions impose that condition of reproduction by reason of their inclusion of positive feelings of that common form. Such a nexus is called a 'society,' and the common form is the 'defining characteristic' of the society. The notion of 'defining characteristic' is allied to the Aristotelian notion of 'substantial form.'

The common element of form is simply a complex eternal object

exemplified in each member of the nexus. But the social order of the nexus is not the mere fact of this common form exhibited by all its members. The reproduction of the common form throughout the nexus is due to the genetic relations of the members of the nexus among each other, and to the additional fact that genetic relations include feelings of the common form. Thus the defining characteristic is inherited throughout the nexus, each member deriving it from those other members of the nexus which are antecedent to its own concrescence.

A nexus enjoys 'personal order' when (α) it is a 'society,' and (β) when the genetic relatedness of its members orders these members 'serially.'

By this 'serial ordering' arising from the genetic relatedness, it is meant that any member of the nexus—excluding the first and the last, if there be such—constitutes a 'cut' in the nexus, so that (a) this member inherits from all members on one side of the cut, and from no members on the other side of the cut, and (b) if A and B are two members of the nexus and B inherits from A, then the side of B's cut, inheriting from B, forms part of the side of A's cut, inheriting from A, and the side of A's cut from which A inherits forms part of the side of B's cut from which B inherits. Thus the nexus forms a single line of inheritance of its defining characteristic. Such a nexus is called an 'enduring object.' It might have been termed a 'person,' in the legal sense of that term. But unfortunately 'person' suggests the notion of consciousness, so that its use would lead to misunderstanding. The nexus 'sustains a character,' and this is one of the meanings of the Latin word *persona*. But an 'enduring object,' *qua* 'person,' does more than sustain a character. For this sustenance arises out of the special genetic relations among the members of the nexus. An ordinary physical object, which has temporal endurance, is a society. In the ideally simple case, it has personal order and is an 'enduring object.' A society may (or may not) be analysable into many strands of 'enduring objects.' This will be the case for most ordinary physical objects. These enduring objects and 'societies,' analysable into strands of enduring objects, are the permanent entities which enjoy adventures of change throughout time and space. For example, they form the subject-matter of the science of dynamics. Actual entities perish, but do not change; they are what they are. A nexus which (i) enjoys social order, and (ii) is analysable into strands of enduring objects

may be termed a 'corpuscular society.' A society may be more or less corpuscular, according to the relative importance of the defining characteristics of the various enduring objects compared to that of the defining characteristic of the whole corpuscular nexus.

SECTION III

There is a prevalent misconception that 'becoming' involves the notion of a unique seriality for its advance into novelty. This is the classic notion of 'time,' which philosophy took over from common sense. Mankind made an unfortunate generalization from its experience of enduring objects. Recently physical science has abandoned this notion. Accordingly we should now purge cosmology of a point of view which it ought never to have adopted as an ultimate metaphysical principle. In these lectures the term 'creative advance' is not to be construed in the sense of a uniquely serial advance.

Finally, the extensive continuity of the physical universe has usually been construed to mean that there is a continuity of becoming. But if we admit that 'something becomes,' it is easy, by employing Zeno's method, to prove that there can be no continuity of becoming.* There is a becoming of continuity, but no continuity of becoming. The actual occasions are the creatures which become, and they constitute a continuously extensive world. In other words, extensiveness becomes, but 'becoming' is not itself extensive.

Thus the ultimate metaphysical truth is atomism. The creatures are atomic. In the present cosmic epoch there is a creation of continuity. Perhaps such creation is an ultimate metaphysical truth holding of all cosmic epochs; but this does not seem to be a necessary conclusion. The more likely opinion is that extensive continuity is a special condition arising from the society of creatures which constitute our immediate epoch. But atomism does not exclude complexity, and universal relativity. Each atom is a system of all things.

The proper balance between atomism and continuity is of importance to physical science. For example, the doctrine here explained, conciliates Newton's corpuscular theory of light with the wave theory. For both a corpuscle, and an advancing element of wave front, are merely a permanent form propagated from atomic creature to atomic creature. A corpuscle is in fact an 'enduring object.' The notion of an

* Cf. Part II, Ch. II, Sec. II; and also my *Science and the Modern World*, Ch. VII, for a discussion of this argument.

'enduring object' is, however, capable of more or less completeness of realization. Thus, in different stages of its career, a wave of light may be more or less corpuscular. A train of such waves at all stages of its career involves social order; but in the earlier stages this social order takes the more special form of loosely related strands of personal order. This dominant personal order gradually vanishes as the time advances. Its defining characteristics become less and less important, as their various features peter out. The waves then become a nexus with important social order, but with no strands of personal order. Thus the train of waves starts as a corpuscular society, and ends as a society which is not corpuscular.

SECTION IV

Finally, in the cosmological scheme here outlined one implicit assumption of the philosophical tradition is repudiated. The assumption is that the basic elements of experience are to be described in terms of one, or all, of the three ingredients, consciousness, thought, sense-perception. The last term is used in the sense of 'conscious perception in the mode of presentational immediacy.' Also in practice sense-perception is narrowed down to visual perception. According to the philosophy of organism these three components are unessential elements in experience, either physical or mental. Any instance of experience is dipolar, whether that instance be God or an actual occasion of the world. The origination of God is from the mental pole, the origination of an actual occasion is from the physical pole; but in either case these elements, consciousness, thought, sense-perception, belong to the derivative 'impure' phases of the concrescence, if in any effective sense they enter at all.

This repudiation is the reason why, in relation to the topic under discussion, the status of presentational immediacy is a recurrent theme throughout the subsequent 'Parts' of these lectures.

Part II Discussions and Applications

CHAPTER I *FACT AND FORM*

SECTION I

All human discourse which bases its claim to consideration on the truth of its statements must appeal to the facts. In none of its branches can philosophy claim immunity to this rule. But in the case of philosophy the difficulty arises that the record of the facts is in part dispersed vaguely through the various linguistic expressions of civilized language and of literature, and is in part expressed more precisely under the influence of schemes of thought prevalent in the traditions of science and philosophy.

In this second part of these lectures, the scheme of thought which is the basis of the philosophy of organism is confronted with various interpretations of the facts widely accepted in European tradition, literary, philosophic, and scientific. So far as concerns philosophy only a selected group can be explicitly mentioned. There is no point in endeavouring to force the interpretations of divergent philosophers into a vague agreement. What is important is that the scheme of interpretation here adopted can claim for each of its main positions the express authority of one, or the other, of some supreme master of thought—Plato, Aristotle, Descartes, Locke, Hume, Kant. But ultimately nothing rests on authority; the final court of appeal is intrinsic reasonableness.

The safest general characterization of the European philosophical tradition is that it consists of a series of footnotes to Plato. I do not mean the systematic scheme of thought which scholars have doubtfully extracted from his writings. I allude to the wealth of general ideas scattered through them. His personal endowments, his wide opportunities for experience at a great period of civilization, his inheritance of an intellectual tradition not yet stiffened by excessive systematization, have made his writing an inexhaustible mine of suggestion. Thus in one sense by stating my belief that the train of thought in these lectures is Platonic, I am doing no more than expressing the hope that it falls within the European tradition. But I do mean

more: I mean that if we had to render Plato's general point of view with the least changes made necessary by the intervening two thousand years of human experience in social organization, in æsthetic attainments, in science, and in religion, we should have to set about the construction of a philosophy of organism. In such a philosophy the actualities constituting the process of the world are conceived as exemplifying the ingression (or 'participation') of other things which constitute the potentialities of definiteness for any actual existence. The things which are temporal arise by their participation in the things which are eternal. The two sets are mediated by a thing which combines the actuality of what is temporal with the timelessness of what is potential. This final entity is the divine element in the world, by which the barren inefficient disjunction of abstract potentialities obtains primordially the efficient conjunction of ideal realization. This ideal realization of potentialities in a primordial actual entity constitutes the metaphysical stability whereby the actual process exemplifies general principles of metaphysics, and attains the ends proper to specific types of emergent order. By reason of the actuality of this primordial valuation of pure potentials, each eternal object has a definite, effective relevance to each concrescent process. Apart from such orderings, there would be a complete disjunction of eternal objects unrealized in the temporal world. Novelty would be meaningless, and inconceivable. We are here extending and rigidly applying Hume's principle, that ideas of reflection are derived from actual facts.

By this recognition of the divine element the general Aristotelian principle is maintained that, apart from things that are actual, there is nothing—nothing either in fact or in efficacy. This is the true general principle which also underlies Descartes' dictum: 'For this reason, when we perceive any attribute, we therefore conclude that some existing thing or substance to which it may be attributed, is necessarily present.' * And again: 'For every clear and distinct conception (*perceptio*) is without doubt something and hence cannot derive its origin from what is nought. . . .' † This general principle will be termed the 'ontological principle.' It is the principle that everything is positively somewhere in actuality, and in potency everywhere.

* *Principles of Philosophy,* Part I, 52; transl. by Haldane and Ross. All quotations from Descartes are from this translation.

† Cf. *Meditation IV,* towards the end.

In one of its applications this principle issues in the doctrine of 'conceptualism.' Thus the search for a reason is always the search for an actual fact which is the vehicle of the reason. The ontological principle, as here defined, constitutes the first step in the description of the universe as a solidarity * of many actual entities. Each actual entity is conceived as an act of experience arising out of data. It is a process of 'feeling' the many data, so as to absorb them into the unity of one individual 'satisfaction.' Here 'feeling' is the term used for the basic generic operation of passing from the objectivity of the data to the subjectivity of the actual entity in question. Feelings are variously specialized operations, effecting a transition into subjectivity. They replace the 'neutral stuff' of certain realistic philosophers. An actual entity is a process, and is not describable in terms of the morphology of a 'stuff.' This use of the term 'feeling' has a close analogy to Alexander's † use of the term 'enjoyment'; and has also some kinship with Bergson's use of the term 'intuition.' A near analogy is Locke's use of the term 'idea,' including 'ideas of particular things' (cf. his *Essay,* III, III, 2, 6, and 7). But the word 'feeling,' as used in these lectures, is even more reminiscent of Descartes. For example: 'Let it be so; still it is at least quite certain that it seems to me that I see light, that I hear noise and that I feel heat. That cannot be false; properly speaking it is what is in me called feeling (*sentire*); and used in this precise sense that is no other thing than thinking.' ††

In Cartesian language, the essence of an actual entity consists solely in the fact that it is a prehending thing (i.e., a substance whose whole essence or nature is to prehend).§ A 'feeling' belongs to the positive species of 'prehensions.' There are two species of prehensions, the 'positive species' and the 'negative species.' An actual entity has a perfectly definite bond with each item in the universe. This determinate bond is its prehension of that item. A negative prehension is the definite exclusion of that item from positive contribution to the subject's own real internal constitution. This doctrine involves the position that a negative prehension expresses a bond. A positive pre-

* The word 'solidarity' has been borrowed from Professor Wildon Carr's *Presidential Address* to the Aristotelian Society, Session 1917–1918. The address—'The Interaction of Body and Mind'—develops the fundamental principle suggested by this word.

† Cf. his *Space, Time and Deity, passim.*

†† Cf. *Meditation II,* Haldane and Ross translation.

§ For the analogue to this sentence cf. *Meditation VI;* substitute *'Ens prehendens' for 'Ens cogitnas.'*

hension is the definite inclusion of that item into positive contribution to the subject's own real internal constitution. This positive inclusion is called its 'feeling' of that time. Other entities are required to express *how* any one item is felt. All actual entities in the actual world, relatively to a given actual entity as 'subject,' are necessarily 'felt' by that subject, though in general vaguely. An actual entity as felt is said to be 'objectified' for that subject. Only a selection of eternal objects is 'felt' by a given subject, and these eternal objects are then said to have 'ingression' in that subject. But those eternal objects which are not felt are not therefore negligible. For each negative prehension has its own subjective form, however trivial and faint. It adds to the emotional complex, though not to the objective data. The emotional complex is the subjective form of the final 'satisfaction.' The importance of negative prehensions arises from the fact, that (i) actual entities form a system, in the sense of entering into each other's constitutions, (ii) that by the ontological principle every entity is felt by some actual entity, (iii) that, as a consequence of (i) and (ii), every entity in the actual world of a concrescent actuality has some gradation of real relevance to that concrescence, (iv) that, in consequence of (iii), the negative prehension of an entity is a positive fact with its emotional subjective form, (v) there is a mutual sensitivity of the subjective forms of prehensions, so that they are not indifferent to each other, (vi) the concrescence issues in one concrete feeling, the satisfaction.

SECTION II

That we fail to find in experience any elements intrinsically incapable of exhibition as examples of general theory, is the hope of rationalism. This hope is not a metaphysical premise. It is the faith which forms the motive for the pursuit of all sciences alike, including metaphysics.

In so far as metaphysics enables us to apprehend the rationality of things, the claim is justified. It is always open to us, having regard to the imperfections of all metaphysical systems, to lose hope at the exact point where we find ourselves. The preservation of such faith must depend on an ultimate moral intuition into the nature of intellectual action—that it should embody the adventure of hope. Such an intuition marks the point where metaphysics—and indeed every science—gains assurance from religion and passes over into religion.

But in itself the faith does not embody a premise from which the theory starts; it is an ideal which is seeking satisfaction. In so far as we believe that doctrine, we are rationalists.

There must, however, be limits to the claim that all the elements in the universe are explicable by 'theory.' For 'theory' itself requires that there be 'given' elements so as to form the material for theorizing. Plato himself recognizes this limitation: I quote from Professor A. E. Taylor's summary of the *Timaeus:*

'In the real world there is always, over and above "law," a factor of the "simply given" or "brute fact," not accounted for and to be accepted simply as given. It is the business of science never to acquiesce in the merely given, to seek to "explain" it as the consequence, in virtue of rational law, of some simpler initial "given." But, however far science may carry this procedure, it is always forced to retain *some* element of brute fact, the merely given, in its account of things. It is the presence in nature of this element of the given, this surd or irrational as it has sometimes been called, which Timaeus appears to be personifying in his language about necessity.' *

So far as the interpretation of Plato is concerned, I rely upon the authority of Professor Taylor. But, apart from this historical question, a clear understanding of the 'given' elements in the world is essential for any form of Platonic realism.

For rationalistic thought, the notion of 'givenness' carries with it a reference beyond the mere data in question. It refers to a 'decision' whereby what is 'given' is separated off from what for that occasion is 'not given.' This element of 'givenness' in things implies some activity procuring limitation. The word 'decision' does not here imply conscious judgment, though in some 'decisions' consciousness will be a factor. The word is used in its root sense of a 'cutting off.' The ontological principle declares that every decision is referable to one or more actual entities, because in separation from actual entities there is nothing, merely nonentity—'The rest is silence.'

The ontological principle asserts the relativity of decision; whereby every decision expresses the relation of the actual thing, *for which* a decision is made, to an actual thing *by which* that decision is made. But 'decision' cannot be construed as a casual adjunct of an actual entity. It constitutes the very meaning of actuality. An actual entity arises from decisions *for* it, and by its very existence provides deci-

* Cf. *Plato, The Man and His Work* (Lincoln MacVeagh, New York, 1927).

sions *for* other actual entities which supersede it. Thus the ontological principle is the first stage in constituting a theory embracing the notions of 'actual entity,' 'givenness,' and 'process.' Just as 'potentiality for process' is the meaning of the more general term 'entity,' or 'thing'; so 'decision' is the additional meaning imported by the word 'actual' into the phrase 'actual entity.' 'Actuality' is the decision amid 'potentiality.' It represents stubborn fact which cannot be evaded. The real internal constitution of an actual entity progressively constitutes a decision conditioning the creativity which transcends that actuality. The Castle Rock at Edinburgh exists from moment to moment, and from century to century, by reason of the decision effected by its own historic route of antecedent occasions. And if, in some vast upheaval of nature, it were shattered into fragments, that convulsion would still be conditioned by the fact that it was the destruction of *that* rock. The point to be emphasized is the insistent particularity of things experienced and of the act of experiencing. Bradley's doctrine *—Wolf-eating-Lamb as a universal qualifying the absolute—is a travesty of the evidence. *That* wolf ate *that* lamb at *that* spot at *that* time: the wolf knew it; the lamb knew it; and the carrion birds knew it. Explicitly in the verbal sentence, or implicitly in the understanding of the subject entertaining it, every expression of a proposition includes demonstrative elements. In fact each word, and each symbolic phrase, is such an element, exciting the conscious prehension of some entity belonging to one of the categories of existence.

SECTION III

Conversely, where there is no decision involving exclusion, there is no givenness. For example, the total multiplicity of Platonic forms is not 'given.' But in respect of each actual entity, there is givenness of such forms. The determinate definiteness of each actuality is an expression of a selection from these forms. It grades them in a diversity of relevance. This ordering of relevance starts from those forms which are, in the fullest sense, exemplified, and passes through grades of relevance down to those forms which in some faint sense are proximately relevant by reason of contrast with actual fact. This whole gamut of relevance is 'given,' and must be referred to the decision of actuality.

* Cf. *Logic,* Bk. I, Ch. II, § 42.

The term 'Platonic form' has here been used as the briefest way of indicating the entities in question. But these lectures are not an exegesis of Plato's writings; the entities in question are not necessarily restricted to those which he would recognize as 'forms.' Also the term 'idea' has a subjective suggestion in modern philosophy, which is very misleading for my present purposes; and in any case it has been used in many senses and has become ambiguous. The term 'essence,' as used by the Critical Realists, also suggests their use of it, which diverges from what I intend. Accordingly, by way of employing a term devoid of misleading suggestions, I use the phrase 'eternal object' for what in the preceding paragraph of this section I have termed a 'Platonic form.' Any entity whose conceptual recognition does not involve a necessary reference to any definite actual entities of the temporal world is called an 'eternal object.'

In this definition the 'conceptual recognition' must of course be an operation constituting a real feeling belonging to some actual entity. The point is that the actual subject which is merely conceiving the eternal object is not thereby in direct relationship to some other actual entity, apart from any other peculiarity in the composition of that conceiving subject. This doctrine applies also to the primordial nature of God, which is his complete envisagement of eternal objects; he is not thereby directly related to the given course of history. The given course of history presupposes his primordial nature, but his primordial nature does not presuppose it.

An eternal object is always a potentiality for actual entities; but in itself, as conceptually felt, it is neutral as to the fact of its physical ingression in any particular actual entity of the temporal world. 'Potentiality' is the correlative of 'givenness.' The meaning of 'givenness' is that what *is* 'given' might not have been 'given'; and that what *is not* 'given' *might have been* 'given.'

Further, in the complete particular 'givenness' for an actual entity there is an element of exclusiveness. The various primary data and the concrescent feelings do not form a mere multiplicity. Their synthesis in the final unity of one actual entity is another fact of 'givenness.' The actual entity terminates its becoming in one complex feeling involving a completely determinate bond with every item in the universe, the bond being either a positive or a negative prehension. This termination is the 'satisfaction' of the actual entity. Thus the addition of another component alters this *synthetic* 'givenness.' Any additional

component is therefore contrary to this integral 'givenness' of the original. This principle may be illustrated by our visual perception of a picture. The pattern of colours is 'given' for us. But an extra patch of red does not constitute a mere addition; it alters the whole balance. Thus in an actual entity the balanced unity of the total 'givenness' excludes anything that is not given.

This is the doctrine of the emergent unity of the superject. An actual entity is to be conceived both as a subject presiding over its own immediacy of becoming, and a superject which is the atomic creature exercising its function of objective immortality. It has become a 'being'; and it belongs to the nature of every 'being' that it is a potential for every 'becoming.'

This doctrine, that the final 'satisfaction' of an actual entity is intolerant of any addition, expresses the fact that every actual entity—since it is what it is—is finally its own reason for what it omits. In the real internal constitution of an actual entity there is always some element which is contrary to an omitted element. Here 'contrary' means the impossibility of joint entry in the same sense. In other words, indetermination has evaporated from 'satisfaction,' so that there is a complete determination of 'feeling,' or of 'negation of feeling,' respecting the universe. This evaporation of indetermination is merely another way of considering the process whereby the actual entity arises from its data. Thus, in another sense, each actual entity includes the universe, by reason of its determinate attitude towards every element in the universe.

Thus the process of becoming is dipolar, (i) by reason of its qualification by the determinateness of the actual world, and (ii) by its conceptual prehensions of the indeterminateness of eternal objects. The process is constituted by the influx of eternal objects into a novel determinateness of feeling which absorbs the actual world into a novel actuality.

The 'formal' constitution of an actual entity is a process of transition from indetermination towards terminal determination. But the indetermination is referent to determinate data. The 'objective' constitution of an actual entity is its terminal determination, considered as a complex of component determinates by reason of which the actual entity is a datum for the creative advance. The actual entity on its physical side is composed of its determinate feelings of its actual

world, and on its mental side is originated by its conceptual appetitions.

Returning to the correlation of 'givenness' and 'potentiality,' we see that 'givenness' refers to 'potentiality,' and 'potentiality' to 'givenness'; also we see that the completion of 'givenness' in actual fact converts the 'not-given' for that fact into 'impossibility' for *that* fact. The individuality of an actual entity involves an exclusive limitation. This element of 'exclusive limitation' is the definiteness essential for the synthetic unity of an actual entity. This synthetic unity forbids the notion of *mere* addition to the included elements.

It is evident that 'givenness' and 'potentiality' are both meaningless apart from a multiplicity of potential entities. These potentialities are the 'eternal objects.' Apart from 'potentiality' and 'givenness,' there can be no nexus of actual things in process of supersession by novel actual things. The alternative is a static monistic universe, without unrealized potentialities; since 'potentiality' is then a meaningless term.

The scope of the ontological principle is not exhausted by the corollary that 'decision' must be referable to an actual entity. Everything must be somewhere; and here 'somewhere' means 'some actual entity.' Accordingly the general potentiality of the universe must be somewhere; since it retains its proximate relevance to actual entities for which it is unrealized. This 'proximate relevance' reappears in subsequent concrescence as final causation regulative of the emergence of novelty. This 'somewhere' is the non-temporal actual entity. Thus 'proximate relevance' means 'relevance as in the primordial mind of God.'

It is a contradiction in terms to assume that some explanatory fact can float into the actual world out of nonentity. Nonentity is nothingness. Every explanatory fact refers to the decision and to the efficacy of an actual thing. The notion of 'subsistence' is merely the notion of how eternal objects can be components of the primordial nature of God. This is a question for subsequent discussion (cf. Part V). But eternal objects, as in God's primordial nature, constitute the Platonic world of ideas.

There is not, however, one entity which is merely the *class* of all eternal objects. For if we conceive any class of eternal objects, there are additional eternal objects which presuppose that class but do not

belong to it. For this reason, at the beginning of this section, the phrase the 'multiplicity of Platonic forms' was used, instead of the more natural phrase the 'class of Platonic forms.' A multiplicity is a type of complex thing which has the unity derivative from some qualification which participates in each of its components severally; but a multiplicity has no unity derivative *merely* from its various components.

SECTION IV

The doctrine just stated—that every explanatory fact refers to the decision and to the efficacy of an actual thing—requires discussion in reference to the ninth Categoreal Obligation. This category states that 'The concrescence of each individual actual entity is internally determined and is externally free.'

The peculiarity of the course of history illustrates the joint relevance of the 'ontological principle' and of this categoreal obligation. The evolution of history can be rationalized by the consideration of the determination of successors by antecedents. But, on the other hand, the evolution of history is incapable of rationalization because it exhibits a selected flux of participating forms. No reason, internal to history, can be assigned why that flux of forms, rather than another flux, should have been illustrated. It is true that any flux must exhibit the character of internal determination. So much follows from the ontological principle. But every instance of internal determination assumes *that* flux up to *that* point. There is no reason why there could be no alternative flux exhibiting that principle of internal determination. The actual flux presents itself with the character of being merely 'given.' It does not disclose any peculiar character of 'perfection.' On the contrary, the imperfection of the world is the theme of every religion which offers a way of escape, and of every sceptic who deplores the prevailing superstition. The Leibnizian theory of the 'best of possible worlds' is an audacious fudge produced in order to save the face of a Creator constructed by contemporary, and antecedent, theologians. Further, in the case of those actualities whose immediate experience is most completely open to us, namely, human beings, the final decision of the immediate subject-superject, constituting the ultimate modification of subjective aim, is the foundation of our experience of responsibility, of approbation or of disapprobation, of self-approval or of self-reproach, of freedom, of em-

phasis. This element in experience is too large to be put aside merely as misconstruction. It governs the whole tone of human life. It can be illustrated only by striking instances from fact or from fiction. But these instances are only conspicuous illustrations of human experience during each hour and each minute. The ultimate freedom of things, lying beyond all determinations, was whispered by Galileo—*E pur si muove*—freedom for the inquisitors to think wrongly, for Galileo to think rightly, and for the world to move in despite of Galileo and inquisitors.

The doctrine of the philosophy of organism is that, however far the sphere of efficient causation be pushed in the determination of components of a concrescence—its data, its emotions, its appreciations, its purposes, its phases of subjective aim—beyond the determination of these components there always remains the final reaction of the self-creative unity of the universe. This final reaction completes the self-creative act by putting the decisive stamp of creative emphasis upon the determinations of efficient cause. Each occasion exhibits its measure of creative emphasis in proportion to its measure of subjective intensity. The absolute standard of such intensity is that of the primordial nature of God, which is neither great nor small because it arises out of no actual world. It has within it no components which are standards of comparison. But in the temporal world for occasions of relatively slight experient intensity, their decisions of creative emphasis are individually negligible compared to the determined components which they receive and transmit. But the final accumulation of all such decisions—the decision of God's nature and the decisions of all occasions—constitutes that special element in the flux of forms in history, which is 'given' and incapable of rationalization beyond the fact that within it every component which is determinable is internally determined.

The doctrine is, that each concrescence is to be referred to a definite free initiation and a definite free conclusion. The initial fact is macrocosmic, in the sense of having equal relevance to all occasions; the final fact is microcosmic, in the sense of being peculiar to that occasion. Neither fact is capable of rationalization, in the sense of tracing the antecedents which determine it. The initial fact is the primordial appetition, and the final fact is the decision of emphasis, finally creative of the 'satisfaction.'

SECTION V

The antithetical terms 'universals' and 'particulars' are the usual words employed to denote respectively entities which nearly, though not quite,* correspond to the entities here termed 'eternal objects' and 'actual entities.' These terms, 'universals' and 'particulars,' both in the suggestiveness of the two words and in their current philosophical use, are somewhat misleading. The ontological principle, and the wider doctrine of universal relativity, on which the present metaphysical discussion is founded, blur the sharp distinction between what is universal and what is particular. The notion of a universal is of that which can enter into the description of many particulars; whereas the notion of a particular is that it is described by universals, and does not itself enter into the description of any other particular. According to the doctrine of relativity which is the basis of the metaphysical system of the present lectures, both these notions involve a misconception. An actual entity cannot be described, even inadequately, by universals; because other actual entities do enter into the description of any one actual entity. Thus every so-called 'universal' is particular in the sense of being just what it is, diverse from everything else; and every so-called 'particular' is universal in the sense of entering into the constitutions of other actual entities. The contrary opinion led to the collapse of Descartes' many substances into Spinoza's one substance; to Leibniz's windowless monads with their pre-established harmony; to the sceptical reduction of Hume's philosophy—a reduction first effected by Hume himself, and reissued with the most beautiful exposition by Santayana in his *Scepticism and Animal Faith.*

The point is that the current view of universals and particulars inevitably leads to the epistemological position stated by Descartes:

'From this I should conclude that I knew the wax by means of vision and not simply by the intuition of the mind; unless by chance I remember that, when looking from a window and saying I see men who pass in the street, I really do not see them, but infer that what I see is men, just as I say that I see wax. And yet what do I see from the window but hats and coats which may cover automatic machines? Yet I judge these to be men. And similarly solely by the

* For example, prehensions and subjective forms are also 'particulars.'

faculty of judgment *(judicandi)* which rests in my mind, I comprehend that which I believed I saw with my eyes.' *

In this passage it is assumed † that Descartes—the Ego in question—is a particular, characterized only by universals. Thus his impressions—to use Hume's words—are characterizations by universals. Thus there is no perception of a particular actual entity. He arrives at the belief in the actual entity by 'the faculty of judgment.' But on this theory he has absolutely no analogy upon which to found any such inference with the faintest shred of probability. Hume, accepting Descartes' account of perception (in this passage), which also belongs to Locke in some sections of his *Essay,* easily draws the sceptical conclusion. Santayana irrefutably exposes the full extent to which this scepticism must be carried. The philosophy of organism recurs to Descartes' alternative theory of *'realitas objectiva,'* and endeavours to interpret it in terms of a consistent ontology. Descartes endeavoured to combine the two theories; but his unquestioned acceptance of the subject-predicate dogma forced him into a representative theory of perception, involving a *'judicium'* validated by our assurance of the power and the goodness of God. The philosophy of organism in its account of prehension takes its stand upon the Cartesian terms *'realitas objectiva,' 'inspectio,'* and *'intuitio.'* The two latter terms are transformed into the notion of a 'positive prehension,' and into operations described in the various categories of physical and conceptual origination. A recurrence to the notion of 'God' is still necessary to mediate between physical and conceptual prehensions, but not in the crude form of giving a limited letter of credit to a *'judicium.'*

Hume, in effect, agrees that 'mind' is a process of concrescence arising from primary data. In his account, these data are 'impressions of sensation'; and in such impressions no elements other than universals are discoverable. For the philosophy of organism, the primary data are always actual entities absorbed into feeling in virtue of certain universals shared alike by the objectified actuality and the experient subject (cf. Part III). Descartes takes an intermediate position. He explains perception in Humian terms, but adds an ap-

* Cf. *Meditation II.*

† Perhaps inconsistently with what Descartes says elsewhere: in other passages the mental activity involved seems to be *analysis* which discovers *'realitas objectiva'* as a component element of the idea in question. There is thus *'inspectio'* rather than *'judicium.'*

prehension of particular actual entities in virtue of an *'inspectio'* and a *'judicium'* effected by the mind (Meditations II and III). Here he is paving the way for Kant, and for the degradation of the world into 'mere appearance.'

All modern philosophy hinges round the difficulty of describing the world in terms of subject and predicate, substance and quality, particular and universal. The result always does violence to that immediate experience which we express in our actions, our hopes, our sympathies, our purposes, and which we enjoy in spite of our lack of phrases for its verbal analysis. We find ourselves in a buzzing * world, amid a democracy of fellow creatures; whereas, under some disguise or other, orthodox philosophy can only introduce us to solitary substances, each enjoying an illusory experience: "O Bottom, thou art changed! what do I see on thee?" The endeavour to interpret experience in accordance with the overpowering deliverance of common sense must bring us back to some restatement of Platonic realism, modified so as to avoid the pitfalls which the philosophical investigations of the seventeenth and eighteenth centuries have disclosed.

The true point of divergence is the false notion suggested by the contrast between the natural meanings of the words 'particular' and 'universal.' The 'particular' is thus conceived as being just its individual self with no necessary relevance to any other particular. It answers to Descartes' definition of substance: 'And when we conceive of substance, we merely conceive an existent thing which requires nothing but itself in order to exist.' † This definition is a true derivative from Aristotle's definition: A primary substance is 'neither asserted of a subject nor present in a subject.' †† We must add the title phrase of Descartes' *The Second Meditation:* 'Of the Nature of the Human Mind; and that it is more easily known than the Body,' together with his two statements: '. . . thought constitutes the nature of thinking substance,' and 'everything that we find in mind is but so many diverse forms of thinking.' § This sequence of quotations exemplifies the set of presuppositions which led to Locke's empiricism and to Kant's critical philosophy—the two dominant influences from

* This epithet is, of course, borrowed from William James.
† Cf. *Principles of Philosophy,* Part I, 51.
†† Cf. *Aristotle* by W. D. Ross, Ch. II.
§ Cf. *Principles of Philosophy,* Part I, 53.

which modern thought is derived. This is the side of seventeenth-century philosophy which is here discarded.

The principle of universal relativity directly traverses Aristotle's dictum, '(A substance) is not present in a subject.' On the contrary, according to this principle an actual entity *is* present in other actual entities. In fact if we allow for degrees of relevance, and for negligible relevance, we must say that every actual entity is present in every other actual entity. The philosophy of organism is mainly devoted to the task of making clear the notion of 'being present in another entity.' This phrase is here borrowed from Aristotle: it is not a fortunate phrase, and in subsequent discussion it will be replaced by the term 'objectification.' The Aristotelian phrase suggests the crude notion that one actual entity is added to another *simpliciter*. This is not what is meant. One rôle of the eternal objects is that they are those elements which express how any one actual entity is constituted by its synthesis of other actual entities, and how that actual entity develops from the primary dative phase into its own individual actual existence, involving its individual enjoyments and appetitions. An actual entity is concrete because it is such a particular concrescence of the universe.

SECTION VI

A short examination of Locke's *Essay Concerning Human Understanding* will throw light on the presuppositions from which the philosophy of organism originates. These citations from Locke are valuable as clear statements of the obvious deliverances of common sense, expressed with their natural limitations. They cannot be bettered in their character of presentations of facts which have to be accepted by any satisfactory system of philosophy.

The first point to notice is that in some of his statements Locke comes very near to the explicit formulation of an organic philosophy of the type being developed here. It was only his failure to notice that his problem required a more drastic revision of traditional categories than that which he actually effected, that led to a vagueness of statement, and the intrusion of inconsistent elements. It was this conservative, other side of Locke which led to his sceptical overthrow by Hume. In his turn, Hume (despite his explicit repudiation in his *Treatise,* Part I, Sec. VI) was a thorough conservative, and in his explanation of mentality and its content never moved away from

the subject-predicate habits of thought which had been impressed on the European mind by the overemphasis on Aristotle's logic during the long medieval period. In reference to this twist of mind, probably Aristotle was not an Aristotelian. But Hume's sceptical reduction of knowledge entirely depends (for its arguments) on the tacit presupposition of the mind as subject and of its contents as predicates—a presupposition which explicitly he repudiates.

The merit of Locke's *Essay Concerning Human Understanding* is its adequacy, and not its consistency. He gives the most dispassionate descriptions of those various elements in experience which common sense never lets slip. Unfortunately he is hampered by inappropriate metaphysical categories which he never criticized. He should have widened the title of his book into 'An Essay Concerning Experience.' His true topic is the analysis of the types of experience enjoyed by an actual entity. But this complete experience is nothing other than what the actual entity is in itself, for itself. I will adopt the pre-Kantian phraseology, and say that the experience enjoyed by an actual entity is that entity *formaliter*. By this I mean that the entity, when considered 'formally,' is being described in respect to those forms of its constitution whereby it is that individual entity with its own measure of absolute self-realization. Its 'ideas of things' are *what* other things are for it. In the phraseology of these lectures, they are its 'feelings.' The actual entity is composite and analysable; and its 'ideas' express how, and in what sense, other things are components in its own constitution. Thus the form of its constitution is to be found by an analysis of the Lockian ideas. Locke talks of 'understanding' and 'perception.' He should have started with a more general neutral term to express the synthetic concrescence whereby the many things of the universe become the one actual entity. Accordingly I have adopted the term 'prehension,' to express the activity whereby an actual entity effects its own concretion of other things.

The 'prehension' of one actual entity by another actual entity is the complete transaction, analysable into the objectification of the former entity as one of the data for the latter, and into the fully clothed feeling whereby the datum is absorbed into the subjective satisfaction—'clothed' with the various elements of its 'subjective form.' But this definition can be stated more generally so as to include the case of the prehension of an eternal object by an actual entity; namely, The 'positive prehension' of an entity by an actual entity is

the complete transaction analysable into the ingression, or objectification, of that entity as a datum for feeling, and into the feeling whereby this datum is absorbed into the subjective satisfaction. I also discard Locke's term 'idea.' Instead of that term, the other things, in their limited rôles as elements for the actual entity in question, are called 'objects' for that thing. There are four main types of objects, namely, 'eternal objects,' 'propositions,' 'objectified' actual entities and nexūs. These 'eternal objects' are Locke's ideas as explained in his *Essay* (I, I, 1), where he writes: *'Idea is the object of thinking.* Every man being conscious to himself that he thinks, and that which his mind is applied about, whilst thinking, being the ideas that are there, it is past doubt that men have in their mind several ideas, such as those expressed by the words, "whiteness, hardness, sweetness, thinking, motion, man, elephant, army, drunkenness," and others.' But later, (III, III, 2), when discussing general terms (and subconsciously, earlier in his discussion of 'substance' in II, XXIII), he adds parenthetically another type of ideas which are practically what I term 'objectified actual entities' and 'nexūs.' He calls them 'ideas of particular things'; and he explains why, in general, such ideas cannot have their separate names. The reason is simple and undeniable: there are too many actual entities. He writes: 'But it is beyond the power of human capacity to frame and retain distinct ideas of all the particular things we meet with: every bird and beast men saw, every tree and plant that affected the senses, could not find a place in the most capacious understanding.' The context shows that it is not the impossibility of an 'idea' of any particular thing which is the seat of the difficulty; it is solely their number. This notion of a direct 'idea' (or 'feeling') of an actual entity is a presupposition of all common sense; Santayana ascribes it to 'animal faith.' But it accords very ill with the sensationalist theory of knowledge which can be derived from other parts of Locke's writings. Both Locke and Descartes wrestle with exactly the same difficulty.

The principle that I am adopting is that consciousness presupposes experience, and not experience consciousness. It is a special element in the subjective forms of some feelings. Thus an actual entity may, or may not, be conscious of some part of its experience. Its experience is its complete formal constitution, including its consciousness, if any. Thus, in Locke's phraseology, its 'ideas of particular things'

are those other things exercising their function as felt components of its constitution. Locke would only term them 'ideas' when these objectifications belong to that region of experience lit up by consciousness. In Section 3 of the same chapter, he definitely makes all knowledge to be 'founded in particular things.' He writes: '. . . yet a distinct name for every particular thing would not be of any great use for the improvement of knowledge: which, *though founded in particular things,** enlarges itself by general views; to which things reduced into parts under general names, are properly subservient.' Thus for Locke, in this passage, there are not first the qualities and then the conjectural particular things; but conversely. Also he illustrates his meaning of a 'particular thing' by a 'leaf,' a 'crow,' a 'sheep,' a 'grain of sand.' So he is not thinking of a particular patch of colour, or other sense-datum. † For example, in Section 7 of the same chapter, in reference to children he writes: 'The ideas of the nurse and the mother are well framed in their minds; and, like pictures of them there, represent only those individuals.' This doctrine of Locke's must be compared with Descartes' doctrine of *'realitas objectiva.'* Locke inherited the dualistic separation of mind from body. If he had started with the one fundamental notion of an actual entity, the complex of ideas disclosed in consciousness would have at once turned into the complex constitution of the actual entity disclosed in its own consciousness, so far as it *is* conscious—fitfully, partially, or not at all. Locke definitely states how ideas become general. In Section 6 of the chapter he writes: '. . . and ideas become general by separating from them the circumstances of time, and place, and any other ideas that may determine them to this or that particular existence.' Thus for Locke the abstract idea is preceded by the 'idea of a particular existent'; '(children) frame an idea which they find those many particulars do partake in.' This statement of Locke's should be compared with the category of conceptual valuation, which is the fourth categoreal obligation.

Locke discusses the constitution of actual things under the term 'real essences.' He writes (Section 13, same chapter): 'And thus the real internal (but generally in substances unknown) constitution of

* My italics.

† As he is in I, II, 15, where he writes, 'The senses at first let in particular ideas, and furnish the yet empty cabinet; . . .' Note the distinction between 'particular ideas' and 'ideas of particular things.'

things, whereon their discoverable qualities depend, may be called their "essence." ' The point is that Locke entirely endorses the doctrine that an actual entity arises out of a complex constitution involving other entities. Though, by his unfortunate use of such terms as 'cabinet,' he puts less emphasis on the notion of 'process' than does Hume.

Locke has in fact stated in his work one main problem for the philosophy of organism. He discovers that the mind is a unity arising out of the active prehension of ideas into one concrete thing. Unfortunately, he presupposes both the Cartesian dualism whereby minds are one kind of particulars, and natural entities are another kind of particulars, and also the subject-predicate dogma. He is thus, in company with Descartes, driven to a theory of representative perception. For example, in one of the quotations already cited he writes: 'And like pictures of them there, *represent* only those individuals.' This doctrine obviously creates an insoluble problem for epistemology, only to be solved either by some sturdy make-believe of 'animal faith,' with Santayana, or by some doctrine of illusoriness—some doctrine of mere appearance, inconsistent if taken as real—with Bradley. Anyhow 'representative perception' can never, within its own metaphysical doctrines, produce the title deeds to guarantee the validity of the representation of fact by idea.

Locke and the philosophers of his epoch—the seventeenth and eighteenth centuries—are misled by one fundamental misconception. It is the assumption, unconscious and uncriticized, that logical simplicity can be identified with priority in the process constituting an experient occasion. Locke founded the first two books of his *Essay* on this presupposition, with the exception of his early sections on 'substance,' which are quoted immediately below. In the third and fourth books of the *Essay* he abandons this presupposition, again unconsciously as it seems.

This identification of priority in logic with priority in practice has vitiated thought and procedure from the first discovery of mathematics and logic by the Greeks. For example, some of the worst defects in educational procedure have been due to it. Locke's nearest approach to the philosophy of organism, and—from the point of view of that doctrine—his main oversight, are best exemplified by the first section of his chapter, 'Of our Complex Ideas of Substances' (II, XXIII, 1). He writes: 'The mind, being, as I have declared,

furnished with a great number of the simple ideas conveyed in by the senses, as they are found in exterior things, or by reflection on its own operations, takes notice, also, that a certain number of these simple ideas go constantly together; which being presumed to belong to one thing, and words being suited to common apprehensions, and made use of for quick dispatch, are called, so united in one subject, by one name; which, by inadvertency, we are apt afterward to talk of and consider as one simple idea, which indeed is a complication of many ideas together: because, as I have said, not imagining how these simple ideas can subsist by themselves, we accustom ourselves to suppose some *substratum* wherein they do subsist, and from which they do result; which therefore we call substance.'

In this section, Locke's first statement, which is the basis of the remainder of the section, is exactly the primary assumption of the philosophy of organism: 'The mind, being furnished with a great number of the simple ideas conveyed in by the senses, *as they are found in exterior things,* . . .' Here the last phrase, 'as they are found in exterior things,' asserted what later I shall call the *vector* character of the primary feelings. The universals involved obtain that status by reason of the fact that *'they are found in exterior things.'* This is Locke's assertion and it is the assertion of the philosophy of organism. It can also be conceived as a development of Descartes' doctrine of *'realitas objectiva.'* The universals are the only elements in the data describable by concepts, because concepts are merely the analytic functioning of universals. But the 'exterior things,' although they are not expressible by concepts in respect to their individual particularity, are no less data for feeling; so that the concrescent actuality arises from feeling their status of individual particularity; and thus that particularity is included as an element from which feelings originate, and which they concern.

The sentence later proceeds with, 'a certain number of these simple ideas go constantly together.' This can only mean that in the immediate perception 'a certain number of these simple ideas' are found together in an exterior thing, and that the recollection of antecedent moments of experience discloses that the same fact, of togetherness in an exterior thing, holds for the same set of simple ideas. Again, the philosophy of organism agrees that this description is true for moments of immediate experience. But Locke, owing to the fact that he veils his second premise under the phrase 'go constantly together,'

omits to consider the question whether the 'exterior things' of the successive moments are to be identified.

The answer of the philosophy of organism is that, in the sense in which Locke is here speaking, the exterior things of successive moments are not to be identified with each other. Each exterior thing is either one actual entity, or (more frequently) is a nexus of actual entities with immediacies mutually contemporary. For the sake of simplicity we will speak only of the simpler case where the 'exterior thing' means one actual entity at the moment in question. But what Locke is explicitly concerned with is the notion of the self-identity of the one enduring physical body which lasts for years, or for seconds, or for ages. He is considering the current philosophical notion of an individualized particular substance (in the Aristotelian sense) which undergoes adventures of change, retaining its substantial form amid transition or accidents. Throughout his *Essay,* he in effect retains this notion while rightly insisting on its vagueness and obscurity. The philosophy of organism agrees with Locke and Hume, that the non-individualized substantial form is nothing else than the collection of universals—or, more accurately, the one complex universal—common to the succession of 'exterior things' at successive moments respectively. In other words, an 'exterior thing' is either one 'actual entity,' or is a 'society' with a 'defining characteristic.' For the organic philosophy, these 'exterior things' (in the former sense) are the final concrete actualities. The individualized substance (of Locke) must be construed to be the historic route constituted by some society of fundamental 'exterior things,' stretching from the first 'thing' to the last 'thing.'

But Locke, throughout his *Essay,* rightly insists that the chief ingredient in the notion of 'substance' is the notion of 'power.' The philosophy of organism holds that in order to understand 'power,' we must have a correct notion of how each individual actual entity contributes to the datum *from which* its successors arise and *to which* they must conform. The reason why the doctrine of power is peculiarly relevant to the enduring things, which the philosophy of Locke's day conceived as individualized substances, is that any likeness between the successive occasions of an historic route procures a corresponding identity between their contributions to the datum of any subsequent actual entity; and it therefore secures a corresponding intensification in the imposition of conformity. The principle is the

same as that which holds for the more sporadic occasions in empty space; but the uniformity along the historic route increases the degree of conformity which that route exacts from the future. In particular each historic route of like occasions tends to prolong itself, by reason of the weight of uniform inheritance derivable from its members. The philosophy of organism abolishes the detached mind. Mental activity is one of the modes of feeling belonging to all actual entities in some degree, but only amounting to conscious intellectuality in some actual entities. This higher grade of mental activity is the intellectual self-analysis of the entity in an earlier stage of incompletion, effected by intellectual feelings produced in a later stage of concrescence.*

The perceptive constitution of the actual entity presents the problem, How can the other actual entities, each with its own formal existence, also enter objectively into the perceptive constitution of the actual entity in question? This is the problem of the solidarity of the universe. The classical doctrines of universals and particulars, of subject and predicate, of individual substances not present in other individual substances, of the externality of relations, alike render this problem incapable of solution. The answer given by the organic philosophy is the doctrine of prehensions, involved in concrescent integrations, and terminating in a definite, complex unity of feeling. To be actual must mean that all actual things are alike objects, enjoying objective immortality in fashioning creative actions; and that all actual things are subjects, each prehending the universe from which it arises. The creative action is the universe always becoming one in a particular unity of self-experience, and thereby adding to the multiplicity which is the universe as many. This insistent concrescence into unity is the outcome of the ultimate self-identity of each entity. No entity—be it 'universal' or 'particular'—can play disjointed rôles. Self-identity requires that every entity have one conjoined, self-consistent function, whatever be the complexity of that function.

SECTION VII

There is another side of Locke, which is his doctrine of 'power.' This doctrine is a better illustration of his admirable adequacy than of his consistency; there is no escape from Hume's demonstration that no such doctrine is compatible with a purely sensationalist

* Cf. Part III, Ch. V, *Process and Reality*.

philosophy. The establishment of such a philosophy, though derivative from Locke, was not his explicit purpose. Every philosophical school in the course of its history requires two presiding philosophers. One of them under the influence of the main doctrines of the school should survey experience with some adequacy, but inconsistently. The other philosopher should reduce the doctrines of the school to a rigid consistency; he will thereby effect a *reductio ad absurdum*. No school of thought has performed its full service to philosophy until these men have appeared. In this way the school of sensationalist empiricism derives its importance from Locke and Hume.

Locke introduces his doctrine of 'power' as follows (II, XXI, 1): *'This idea how got.*—The mind being every day informed, by the senses, of the alteration of those simple ideas it observes in things without, and taking notice how one comes to an end and ceases to be, and another begins to exist, which was not before; reflecting also on what passes within itself, and observing a constant change of its ideas, sometimes by the impression of outward objects on the senses, and sometimes by the determination of its own choice; and concluding, from what it has so constantly observed to have been, that the like changes will for the future be made in the same thing by like agents, and by the like ways; considers in one thing the possibility of having any of its simple ideas changed, and in another the possibility of making that change; and so comes by that idea which we call 'power.' Thus we say, fire has a power to melt gold; . . . and gold has a power to be melted: . . . In which and like cases, the power we consider is in reference to the change of perceivable ideas: for we cannot observe any alteration to be made in, or operation upon, anything, but by the observable change of its sensible ideas; nor conceive any alteration to be made, but by conceiving a change of some of its ideas. . . . Power thus considered is twofold; viz. as able to make, or able to receive, any change: the one may be called 'active,' and the other 'passive,' power. . . . I confess power includes in it some kind of relation,—a relation to action or change; as, indeed, which of our ideas, of what kind soever, when attentively considered, does not. For our ideas of extension, duration and number, do they not all contain in them a secret relation of the parts? Figure and motion have something relative in them much more visibly. And sensible qualities, as colours and smells, etc., what are they but the powers of different bodies in relation to our perception! . . . Our

idea therefore of power, I think, may well have a place amongst other simple ideas, and be considered as one of them, being one of those that make a principal ingredient in our complex ideas of substances, as we shall hereafter have occasion to observe.'

In this important passage, Locke enunciates the main doctrines of the philosophy of organism, namely: the principle of relativity; the relational character of eternal objects, whereby they constitute the forms of the objectifications of actual entities for each other; the composite character of an actual entity (i.e., a substance); the notion of 'power' as making a principal ingredient in that of actual entity (substance). In this latter notion, Locke adumbrates both the ontological principle, and also the principle that the 'power' of one actual entity on the other is simply how the former is objectified in the constitution of the other. Thus the problem of perception and the problem of power are one and the same, at least so far as perception is reduced to mere prehension of actual entities. Perception, in the sense of consciousness of such prehension, requires the additional factor of the conceptual prehension of eternal objects, and a process of integration of the two factors (cf. Part III).

Locke's doctrine of 'power' is reproduced in the philosophy of organism by the doctrine of the two types of objectification, namely, (α) 'causal objectification,' and (β) 'presentational objectification.'

In 'causal objectification' what is felt *subjectively* by the objectified actual entity is transmitted *objectively* to the concrescent actualities which supersede it. In Locke's phraseology the objectified actual entity is then exerting 'power.' In this type of objectification the eternal objects, relational between object and subject, express the formal constitution of the objectified actual entity.

In 'presentational objectification' the relational eternal objects fall into two sets, one set contributed by the 'extensive' perspective of the perceived from the position of the perceiver, and the other set by the antecedent concrescent phases of the perceiver. What is ordinarily termed 'perception' is consciousness of presentational objectification. But according to the philosophy of organism there can be consciousness of both types of objectification. There can be such consciousness of both types because, according to this philosophy, the knowable is the complete nature of the knower, at least such phases of it as are antecedent to that operation of knowing.

Locke misses one essential doctrine, namely, that the doctrine of internal relations makes it impossible to attribute 'change' to any actual entity. Every actual entity is what it is, and is with its definite status in the universe, determined by its internal relations to other actual entities. 'Change' is the description of the adventures of eternal objects in the evolving universe of actual things.

The doctrine of internal relations introduces another consideration which cannot be overlooked without error. Locke considers the 'real essence' and the 'nominal essence' of things. But on the theory of the general relativity of actual things between each other, and of the internality of these relations, there are two distinct notions hidden under the term 'real essence,' both of importance. Locke writes (III, III, 15): 'Essence may be taken for the being of anything, whereby it is what it is. And thus the real internal (but generally in substances unknown) constitution of things, whereon their discoverable qualities depend, may be called their "essence." . . . It is true, there is ordinarily supposed a real constitution of the sort of things: and it is past doubt there must be some real constitution, on which any collection of simple ideas co-existing must depend. But it being evident that things are ranked under names into sorts or species only as they agree to certain abstract ideas to which we have annexed these names, the essence of each genus or sort comes to be nothing but that abstract idea, which the general or "sortal" (if I may have leave so to call it from "sort" as I do "general" from "genus") name stands for. And this we shall find to be that which the word "essence" imparts in its familiar use. These two sorts of essences, I suppose, may not unfitly be termed, the one the "real," the other the "nominal" essence.'

The fundamental notion of the philosophy of organism is expressed in Locke's phrase, 'it is past doubt there must be some real constitution, on which any collection of simple ideas co-existing must depend.' Locke makes it plain (cf. II, II, 1) that by a 'simple idea' he means the ingression in the actual entity (illustrated by 'a piece of wax,' 'a piece of ice,' 'a rose') of some abstract quality which is not complex (illustrated by 'softness,' 'warmth,' 'whiteness'). For Locke such simple ideas, *co-existing* in an actual entity, require a *real* constitution for that entity. Now in the philosophy of organism, passing beyond Locke's explicit statement, the notion of a real con-

stitution is taken to mean that the eternal objects function by introducing the multiplicity of actual entities as constitutive of the actual entity in question. Thus the constitution is 'real' because it assigns its status in the real world to the actual entity. In other words the actual entity, in virtue of being *what* it is, is also *where* it is. It is somewhere because it is some actual thing with its correlated actual world. This is the direct denial of the Cartesian doctrine, '. . . an existent thing which requires nothing but itself in order to exist.' It is also inconsistent with Aristotle's phrase, 'neither asserted of a subject, nor present in a subject.'

I am certainly not maintaining that Locke grasped explicitly the implications of his words as thus developed for the philosophy of organism. But it is a short step from a careless phrase to a flash of insight; nor is it unbelievable that Locke saw further into metaphysical problems than some of his followers. But abandoning the question of what Locke had in his own mind, the 'organic doctrine' demands a 'real essence' in the sense of a complete analysis of the relations, and inter-relations of the actual entities which are formative of the actual entity in question, and an 'abstract essence' in which the specified actual entities are replaced by the notions of unspecified entities in *such* a combination; this is the notion of an unspecified actual entity. Thus the real essence involves real objectifications of specified actual entities; the abstract essence is a complex eternal object. There is nothing self-contradictory in the thought of many actual entities with the same abstract essence; but there can only be one actual entity with the same real essence. For the real essence indicates 'where' the entity is, that is to say, its status in the real world; the abstract essence omits the particularity of the status.

The philosophy of organism in its appeal to the facts can thus support itself by an appeal to the insight of John Locke, who in British philosophy is the analogue to Plato, in the epoch of his life, in personal endowments, in width of experience, and in dispassionate statement of conflicting intuitions.

This doctrine of organism is the attempt to describe the world as a process of generation of individual actual entities, each with its own absolute self-attainment. This concrete finality of the individual is nothing else than a decision referent beyond itself. The 'perpetual perishing' (cf. Locke, B II, C XIV, D 1) of individual absoluteness is thus foredoomed. But the 'perishing' of absoluteness is the at-

tainment of 'objective immortality.' This last conception expresses the further element in the doctrine of organism—that the process of generation is to be described in terms of actual entities.

CHAPTER II *THE EXTENSIVE CONTINUUM*

SECTION I

We must first consider the perceptive mode in which there is clear, distinct consciousness of the 'extensive' relations of the world. These relations include the 'extensiveness' of space and the 'extensiveness' of time. Undoubtedly, this clarity, at least in regard to space, is obtained only in ordinary perception through the senses. This mode of perception is here termed 'presentational immediacy.' In this 'mode' the contemporary world is consciously prehended as a continuum of extensive relations.

It cannot be too clearly understood that some chief notions of European thought were framed under the influence of a misapprehension, only partially corrected by the scientific progress of the last century. This mistake consists in the confusion of mere potentiality with actuality. Continuity concerns what is potential; whereas actuality is incurably atomic.

This misapprehension is promoted by the neglect of the principle that, so far as physical relations are concerned, contemporary events happen in *causal* independence of each other.* This principle will have to be explained later, in connection with an examination of process and of time. It receives an exemplification in the character of our perception of the world of contemporary actual entities. That contemporary world is objectified for us as *'realitas objectiva,'* illustrating bare extension with its various parts discriminated by differences of sense data. These qualities, such as colours, sounds, bodily feelings, tastes, smells, together with the perspectives introduced by extensive relationships, are the relational eternal objects whereby the contemporary actual entities are elements in our constitution. This is

* This principle lies on the surface of the fundamental Einsteinian formula for the physical continuum.

the type of objectification which (in Sec. VII of the previous chapter) has been termed 'presentational objectification.'

In this way, by reason of the principle of contemporary independence, the contemporary world is objectified for us under the aspect of passive potentiality. The very sense data by which its parts are differentiated are supplied by antecedent states of our own bodies, and so is their distribution in contemporary space. Our direct perception of the contemporary world is thus reduced to extension, defining (i) our own geometrical perspectives, and (ii) possibilities of mutual perspectives for other contemporary entities *inter se,* and (iii) possibilities of division. These possibilities of division constitute the external world a continuum. For a continuum is divisible; so far as the contemporary world is divided by actual entities, it is not a continuum, but is atomic. Thus the contemporary world is perceived with its potentiality for extensive division, and not in its actual atomic division.

The contemporary world as perceived by the senses is the datum for contemporary actuality, and is therefore continuous—divisible but not divided. The contemporary world is in fact divided and atomic, being a multiplicity of definite actual entities. These contemporary actual entities are divided from each other, and are not themselves divisible into other contemporary actual entities. This antithesis will have to be discussed later.* But it is necessary to adumbrate it here.

This limitation of the way in which the contemporary actual entities are relevant to the 'formal' existence of the subject in question is the first example of the general principle, that objectification relegates into irrelevance, or into a subordinate relevance, the full constitution of the objectified entity. Some real component in the objectified entity assumes the rôle of being how that particular entity is a datum in the experience of the subject. In this case, the objectified contemporaries are only directly relevant to the subject in their character of arising from a datum which is an extensive continuum. They do, in fact, atomize this continuum; but the aboriginal potentiality, which they include and realize, is what they contribute as the relevant factor in their objectifications. They thus exhibit the community of contemporary actualities as a common world with mathematical relations—where the term 'mathematical' is used

* Cf. Part IV, *Process and Reality.*

in the sense in which it would have been understood by Plato, Euclid, and Descartes, before the modern discovery of the true definition of pure mathematics.

The bare mathematical potentialities of the extensive continuum require an additional content in order to assume the rôle of real objects for the subject. This content is supplied by the eternal objects, termed sense-data. These objects are 'given' for the experience of the subject. Their givenness does not arise from the 'decision' of the contemporary entities which are thus objectified. It arises from the functioning of the antecedent physical body of the subject; and this functioning can in its turn be analysed as representing the influence of the more remote past, a past common alike to the subject and to its contemporary actual entities. Thus these sense-data are eternal objects playing a complex relational rôle; they connect the actual entities of the past with the actual entities of the contemporary world, and thereby effect objectifications of the contemporary things and of the past things. For instance, we see the contemporary chair, but we see it *with* our eyes; and we touch the contemporary chair, but we touch it *with* our hands. Thus colours objectify the chair in one way, and objectify the eyes in another way, as elements in the experience of the subject. Also touch objectifies the chair in one way, and objectifies the hands in another way, as elements in the experience of the subject. But the eyes and the hands are in the past (the almost immediate past) and the chair is in the present. The chair, thus objectified, is the objectification of a contemporary nexus of actual entities in its unity as one nexus. This nexus is illustrated as to its constitution by the spatial region, with its perspective relations. This region is, in fact, atomized by the members of the nexus. By the operation of the category of transmutation (cf. Parts III and IV), in the objectification an abstraction is made from the multiplicity of members and from all components of their formal constitutions, except the occupation of this region. This prehension, in the particular example considered, will be termed the prehension of a 'chair-image.' Also the intervention of the past is not confined to antecedent eyes and hands. There is a more remote past throughout nature external to the body. The direct relevance of this remote past, relevant by reason of its direct objectification in the immediate subject, is practically negligible, so far as concerns prehensions of a strictly physical type.

But external nature has an indirect relevance by the transmission through it of analogous prehensions. In this way there are in it various historical routes of intermediate objectifications. Such relevant historical routes lead up to various parts of the animal body, and transmit into it prehensions which form the physical influence of the external environment on the animal body. But this external environment which is in the past of the concrescent subject is also, with negligible exceptions, in the past of the nexus which is the objectified chair-image. If there be a 'real chair,' there will be another historical route of objectifications from nexus to nexus in this environment. The members of each nexus will be mutually contemporaries. Also the historical route will lead up to the nexus which is the chair-image. The complete nexus, composed of this historical route and the chair-image, will form a 'corpuscular' society. This society is the 'real chair.'

The prehensions of the concrescent subject and the formal constitutions of the members of the contemporary nexus which is the chair-image are thus conditioned by the properties of the same environment in the past. The animal body is so constructed that, with rough accuracy and in normal conditions, important emphasis is thus laid upon those regions in the contemporary world which are particularly relevant for the future existence of the enduring object of which the immediate percipient is one occasion.

A reference to the Category of Transmutation will show that perception of contemporary 'images' in the mode of 'presentational immediacy' is an 'impure' prehension. The subsidiary 'pure' physical prehensions are the components which provide some definite information as to the physical world; the subsidiary 'pure' mental prehensions are the components by reason of which the theory of 'secondary qualities' was introduced into the theory of perception. The account here given traces back these secondary qualities to their root in physical prehensions expressed by the '*withness* of the body.'

If the familiar correlations between physical paths and the life-histories of a chair and of the animal body are not satisfied, we are apt to say that our perceptions are delusive. The word 'delusive' is all very well as a technical term; but it must not be misconstrued to mean that what we *have* directly perceived, we have *not* directly perceived. Our direct perception, via our senses, of an immediate

extensive shape, in a certain geometrical perspective to ourselves, and in certain general geometrical relations to the contemporary world, remains an ultimate fact. Our inferences are at fault. In Cartesian phraseology, it is a final *'inspectio'* (also termed *'intuitio'*) which, when purged of all *'judicium'*—i.e. of 'inference'—is final for belief. This whole question of 'delusive' perception must be considered later * in more detail. We can, however, see at once that there are grades of 'delusiveness.' There is the non-delusive case, when we see a chair-image and there *is* a chair. There is the partially delusive case when we have been looking in a mirror; in this case, the chair-image we see is not the culmination of the corpuscular society of entities which we call the real chair. Finally, we may have been taking drugs, so that the chair-image we see has no familiar counterpart in any historical route of a corpuscular society. Also there are other delusive grades where the lapse of time is the main element. These cases are illustrated by our perceptions of the heavenly bodies. In delusive cases we are apt, in a confusing way, to say that the societies of entities which we did not see but correctly inferred are the things that we 'really' saw.

The conclusion of this discussion is that the ingression of the eternal objects termed 'sense-data' into the experience of a subject cannot be construed as the simple objectification of the actual entity to which, in ordinary speech, we ascribe that sense-datum as a quality. The ingression involves a complex relationship, whereby the sense-datum emerges as the 'given' eternal object by which some past entities are objectified (for example, colour seen *with* the eyes and bad temper inherited *from* the viscera) and whereby the sense-datum also enters into the objectification of a society of actual entities in the contemporary world. Thus a sense-datum has ingression into experience by reason of its forming the *what* of a very complex multiple integration of prehensions within that occasion. For example, the ingression of a visual sense-datum involves the causal objectification of various antecedent bodily organs and the presentational objectification of the shape seen, this shape being a nexus of contemporary actual entities. In this account of the ingression of sense-data, the animal body is nothing more than the most intimately relevant part of the antecedent settled world. To sum up this account: When we perceive a contemporary extended shape which we term a 'chair,' the sense-data involved are not necessarily elements in the 'real

* Cf. Part III, Chs. III to V, *Process and Reality*.

internal constitution' of this chair-image: they are elements—in some way of feeling—in the 'real internal constitutions' of those antecedent organs of the human body *with* which we perceive the 'chair.' The *direct* recognition of such antecedent actual entities, *with* which we perceive contemporaries, is hindered and, apart from exceptional circumstances, rendered impossible by the spatial and temporal vagueness which infect such data. Later * the whole question of this perception of a nexus vaguely, that is to say, without distinction of the actual entities composing it, is discussed in terms of the theory of prehensions, and in relation to the Category of Transmutation.

SECTION II

This account of 'presentational immediacy' presupposes two metaphysical assumptions:

(i) That the actual world, in so far as it is a community of entities which are settled, actual, and already become, conditions and limits the potentiality for creativeness beyond itself. This 'given' world provides determinate data in the form of those objectifications of themselves which the characters of its actual entities can provide. This is a limitation laid upon the general potentiality provided by eternal objects, considered merely in respect to the generality of their natures. Thus, relatively to any actual entity, there is a 'given' world of settled actual entities and a 'real' potentiality, which is the datum for creativeness beyond that standpoint. This datum, which is the primary phase in the process constituting an actual entity, is nothing else than the actual world itself in its character of a possibility for the process of being felt. This exemplifies the metaphysical principle that every 'being' is a potential for a 'becoming.' The actual world is the 'objective content' of each new creation.

Thus we have always to consider two meanings of potentiality: (a) the 'general' potentiality, which is the bundle of possibilities, mutually consistent or alternative, provided by the multiplicity of eternal objects, and (b) the 'real' potentiality, which is conditioned by the data provided by the actual world. General potentiality is absolute, and real potentiality is relative to some actual entity, taken as a standpoint whereby the actual world is defined. It must be remembered that the phrase 'actual world' is like 'yesterday' and 'tomorrow,' in that it alters its meaning according to standpoint. The

* Cf. Part III, Chs. III to V, *Process and Reality*.

actual world must always mean the community of all actual entities, including the primordial actual entity called 'God' and the temporal actual entities.

Curiously enough, even at this early stage of metaphysical discussion, the influence of the 'relativity theory' of modern physics is important. According to the classical 'uniquely serial' view of time, two contemporary actual entities define the same actual world. According to the modern view no two actual entities define the same actual world. Actual entities are called 'contemporary' when neither belongs to the 'given' actual world defined by the other.

The differences between the actual worlds of a pair of contemporary entities, which are in a certain sense 'neighbours,' are negligible for most human purposes. Thus the difference between the 'classical' and the 'relativity' view of time only rarely has any important relevance. I shall always adopt the relativity view; for one reason, because it seems better to accord with the general philosophical doctrine of relativity which is presupposed in the philosophy of organism; and for another reason, because with rare exceptions the classical doctrine can be looked on as a special case of the relativity doctrine—a case which does not seem to accord with experimental evidence. In other words, the classical view seems to limit a general philosophical doctrine; it is the larger assumption; and its consequences, taken in conjunction with other scientific principles, seem to be false.

(ii) The second metaphysical assumption is that the real potentialities relative to all standpoints are coördinated as diverse determinations of one extensive continuum. This extensive continuum is one relational complex in which all potential objectifications find their niche. It underlies the whole world, past, present, and future. Considered in its full generality, apart from the additional conditions proper only to the cosmic epoch of electrons, protons, molecules, and star-systems, the properties of this continuum are very few and do not include the relationships of metrical geometry. An extensive continuum is a complex of entities united by the various allied relationships of whole to part, and of overlapping so as to possess common parts, and of contact, and of other relationships derived from these primary relationships. The notion of a 'continuum' involves both the property of indefinite divisibility and the property of unbounded extension. There are always entities beyond entities, because nonentity is no boundary. This extensive continuum expresses the

solidarity of all possible standpoints throughout the whole process of the world. It is not a fact prior to the world; it is the first determination of order—that is, of real potentiality—arising out of the general character of the world. In its full generality beyond the present epoch, it does not involve shapes, dimensions, or measurability; these are additional determinations of real potentiality arising from our cosmic epoch.

This extensive continuum is 'real,' because it expresses a fact derived from the actual world and concerning the contemporary actual world. All actual entities are related according to the determinations of this continuum; and all possible actual entities in the future must exemplify these determinations in their relations with the already actual world. The reality of the future is bound up with the reality of this continuum. It is the reality of what is potential, in its character of a real component of what is actual. Such a real component must be interpreted in terms of the relatedness of prehensions. This task will be undertaken later.*

Actual entities atomize the extensive continuum. This continuum is in itself merely the potentiality for division; an actual entity effects this division. The objectification of the contemporary world merely expresses that world in terms of its potentiality for subdivision and in terms of the mutual perspectives which any such subdivision will bring into real effectiveness. These are the primary governing data for any actual entity; for they express how all actual entities are in the solidarity of one world. With the becoming of any actual entity what was previously potential in the space-time continuum is now the primary real phase in something actual. For each process of concrescence a regional standpoint in the world, defining a limited potentiality for objectifications, has been adopted. In the mere extensive continuum there is no principle to determine what regional quanta shall be atomized, so as to form the real perspective standpoint for the primary data constituting the basic phase in the concrescence of an actual entity. The factors in the actual world whereby this determination is effected will be discussed at a later stage of this investigation. They constitute the initial phase of the 'subjective aim.' This initial phase is a direct derivate from God's primordial nature. In this function, as in every other, God is the organ of novelty, aiming at intensification.

* Cf. Part IV, Ch. V, *Process and Reality*.

In the mere continuum there are contrary potentialities; in the actual world there are definite atomic actualities determining one coherent system of real divisions throughout the region of actuality. Every actual entity in its relationship to other actual entities is in this sense somewhere in the continuum, and arises out of the data provided by this standpoint. But in another sense it is everywhere throughout the continuum; for its constitution includes the objectifications of the actual world and thereby includes the continuum; also the potential objectifications of itself contribute to the real potentialities whose solidarity the continuum expresses. Thus the continuum is present in each actual entity, and each actual entity pervades the continuum.

This conclusion can be stated otherwise. Extension, apart from its spatialization and temporalization, is that general scheme of relationships providing the capacity that many objects can be welded into the real unity of one experience. Thus, an act of experience has an objective scheme of extensive order by reason of the double fact that its own perspective standpoint has extensive content, and that the other actual entities are objectified with the retention of their extensive relationships. These extensive relationships are more fundamental than their more special spatial and temporal relationships. Extension is the most general scheme of real potentiality, providing the background for all other organic relations. The potential scheme does not determine its own atomization by actual entities. It is divisible; but its real division by actual entities depends upon more particular characteristics of the actual entities constituting the antecedent environment. In respect to time, this atomization takes the special form * of the 'epochal theory of time.' In respect to space, it means that every actual entity in the temporal world is to be credited with a spatial volume for its perspective standpoint. These conclusions are required by the consideration † of Zeno's arguments, in connection with the presumption that an actual entity is an act of experience. The authority of William James can be quoted in support of this conclusion. He writes: 'Either your experience is of no content, of no change, or it is of a perceptible amount of content or change. Your acquaintance with reality grows literally by buds or drops of perception. Intellectually and on reflection you can divide these into com-

* Cf. my *Science and the Modern World,* Ch. VII.

† Cf. *loc. cit.;* and Part IV of the present work.

ponents, but as immediately given, they come totally or not at all.' * James also refers to Zeno. In substance I agree with his argument from Zeno; though I do not think that he allows sufficiently for those elements in Zeno's paradoxes which are the product of inadequate mathematical knowledge. But I agree that a valid argument remains after the removal of the invalid parts.

The argument, so far as it is valid, elicits a contradiction from the two premises: (i) that in a becoming something (*res vera*) becomes, and (ii) that every act of becoming is divisible into earlier and later sections which are themselves acts of becoming. Consider, for example, an act of becoming during one second. The act is divisible into two acts, one during the earlier half of the second, the other during the later half of the second. Thus that which becomes during the whole second presupposes that which becomes during the first half-second. Analogously, that which becomes during the first half-second presupposes that which becomes during the first quarter-second, and so on indefinitely. Thus if we consider the process of becoming up to the beginning of the second in question, and ask what then becomes, no answer can be given. For, whatever creature we indicate presupposes an earlier creature which became after the beginning of the second and antecedently to the earlier creature. Therefore there is nothing which becomes, so as to effect a transition into the second in question.

The difficulty is not evaded by assuming that something becomes at each non-extensive instant of time. For at the beginning of the second of time there is no next instant at which something can become.

Zeno in his 'Arrow in Its Flight' seems to have had an obscure grasp of this argument. But the introduction of motion brings in irrelevant details. The true difficulty is to understand how the arrow survives the lapse of time. Unfortunately Descartes' treatment of 'endurance' is very superficial, and subsequent philosophers have followed his example.

In his 'Achilles and the Tortoise' Zeno produces an invalid argument depending on ignorance of the theory of infinite convergent numerical series. Eliminating the irrelevant details of the race and

* Cf. *Some Problems in Philosophy*, Ch. X; my attention was drawn to this passage by its quotation in *Religion in the Philosophy of William James*, by Professor J. S. Bixler.

of motion—details which have endeared the paradox to the literature of all ages—consider the first half-second as one act of becoming, the next quarter-second as another such act, the next eighth-second as yet another, and so on indefinitely. Zeno then illegitimately assumes this infinite series of acts of becoming can never be exhausted. But there is no need to assume that an infinite series of acts of becoming, with a first act, and each act with an immediate successor is inexhaustible in the process of becoming. Simple arithmetic assures us that the series just indicated will be exhausted in the period of one second. The way is then open for the intervention of a new act of becoming which lies beyond the whole series. Thus this paradox of Zeno is based upon a mathematical fallacy.

The modification of the 'Arrow' paradox, stated above, brings out the principle that every act of becoming must have an immediate successor, if we admit that something becomes. For otherwise we cannot point out what creature becomes as we enter upon the second in question. But we cannot, in the absence of some additional premise, infer that every act of becoming must have had an immediate predecessor.

The conclusion is that in every act of becoming there is the becoming of something with temporal extension; but that the act itself is not extensive, in the sense that it is divisible into earlier and later acts of becoming which correspond to the extensive divisibility of what has become.

In this section, the doctrine is enunciated that the creature is extensive, but that its act of becoming is not extensive. This topic is resumed in Part IV. However, some anticipation of Parts III and IV is now required.

The *res vera,* in its character of concrete satisfaction, is divisible into prehensions which concern its first temporal half and into prehensions which concern its second temporal half. This divisibility is what constitutes its extensiveness. But this concern with a temporal and spatial sub-region means that the datum of the prehension in question is the actual world, objectified with the perspective due to that sub-region. A prehension, however, acquires subjective form, and this subjective form is only rendered fully determinate by integration with conceptual prehensions belonging to the mental pole of the *res vera.* The concrescence is dominated by a subjective aim which essentially concerns the creature as a final superject. This subjective aim

is this subject itself determining its own self-creation as one creature. Thus the subjective aim does not share in this divisibility. If we confine attention to prehensions concerned with the earlier half, their subjective forms have arisen from nothing. For the subjective aim which belongs to the whole is now excluded. Thus the evolution of subjective form could not be referred to any actuality. The ontological principle has been violated. Something has floated into the world from nowhere.

The summary statement of this discussion is, that the mental pole determines the subjective forms and that this pole is inseparable from the total *res vera.*

SECTION III

The discussion of the previous sections has merely given a modern shape to the oldest of European philosophic doctrines. But as a doctrine of common sense, it is older still—as old as consciousness itself. The most general notions underlying the words 'space' and 'time' are those which this discussion has aimed at expressing in their true connection with the actual world. The alternative doctrine, which is the Newtonian cosmology, emphasized the 'receptacle' theory of space-time, and minimized the factor of potentiality. Thus bits of space and time were conceived as being as actual as anything else, and as being 'occupied' by other actualities which were the bits of matter. This is the Newtonian 'absolute' theory of space-time, which philosophers have never accepted, though at times some have acquiesced. Newton's famous *Scholium* * to his first eight definitions in his *Principia* expresses this point of view with entire clearness:

'Hitherto I have laid down the definitions of such words as are less known, and explained the sense in which I would have them to be understood in the following discourse. I do not define time, space, place and motion, as being well known to all. Only I must observe, that the vulgar conceive those quantities under no other notions but from the relation they bear to sensible objects. And thence arise certain prejudices, for the removing of which, it will be convenient to distinguish them into absolute and relative, true and apparent, mathematical and common.

'I. Absolute, true, and mathematical time, of itself, and from its

* Andrew Motte's translation; new edition revised, London, 1803.

own nature, flows equably without regard to anything external, and by another name is called duration: relative, apparent, and common time, is some sensible and external (whether accurate or unequable) measure of duration by means of motion, which is commonly used instead of true time; such as an hour, a day, a month, a year.

'II. Absolute space, in its own nature, and without regard to anything external, remains always similar and immovable. Relative space is some movable dimension or measure of the absolute space; which our senses determine by its position to bodies, and which is vulgarly taken for immovable space; . . . absolute and relative space are the same in figure and magnitude; but they do not remain always numerically the same. . . .

'IV. . . . As the order of the parts of time is immutable, so also is the order of the parts of space. Suppose those parts to be moved out of their places, and they will be moved (if the expression may be allowed) out of themselves. For times and spaces are, as it were, the places as well of themselves as of all other things. All things are placed in time as to order of situation. It is from their essence or nature that they are places; and that the primary places of things should be movable, is absurd. These are, therefore, the absolute places; and translations out of those places are the only absolute motions. . . . Now no other places are immovable but those that, from infinity to infinity, do all retain the same given positions one to another; and upon this account must ever remain unmoved; and do thereby constitute, what I call, immovable space. The causes by which true and relative motions are distinguished, one from the other, are the forces impressed upon bodies to generate motion. True motion is neither generated nor altered, but by some force impressed upon the body moved: but relative motion may be generated or altered without any force impressed upon the body. For it is sufficient only to impress some force on other bodies with which the former is compared, that by their giving way, that relation may be changed, in which the relative rest or motion of this other body did consist. . . . The effects which distinguish absolute from relative motion are the forces of receding from the axis of circular motion. For there are no such forces in a circular motion purely relative, but, in a true and absolute circular motion, they are greater or less, according to the quantity of motion. . . . Wherefore relative quantities are not the quantities themselves, whose names they

bear, but those sensible measures of them (either accurate or inaccurate) which are commonly used instead of the measured quantities themselves. . . .'

I have quoted at such length from Newton's *Scholium* because this document constitutes the clearest, most definite, and most influential statement among the cosmological speculations of mankind, speculations of a type which first assume scientific importance with the Pythagorean school preceding and inspiring Plato. Newton is presupposing four types of entities which he does not discriminate in respect to their actuality: for him minds are actual things, bodies are actual things, absolute durations of time are actual things, and absolute places are actual things. He does not use the word 'actual'; but he is speaking of matter of fact, and he puts them all on the same level in that respect. The result is to land him in a clearly expressed but complex and arbitrary scheme of relationships between spaces *inter se;* between durations *inter se;* and between minds, bodies, times and places, for the conjunction of them all into the solidarity of the one universe. For the purposes of science it was an extraordinarily clarifying statement, that is to say, for all the purposes of science within the next two hundred years, and for most of its purposes since that period. But, as a fundamental statement, it lies completely open to sceptical attack; and also, as Newton himself admits, diverges from common sense—'the vulgar conceive those quantities under no other notions but from the relation they bear to sensible objects.' Kant only saved it by reducing it to the description of a construct by means of which 'pure intuition' introduces an order for chaotic data; and for the schools of transcendentalists derived from Kant this construct has remained in the inferior position of a derivative from the proper ultimate substantial reality. For them it is an element in 'appearance'; and appearance is to be distinguished from reality. The philosophy of organism is an attempt, with the minimum of critical adjustment, to return to the conceptions of the 'vulgar.' In the first place, the discussion must fasten on the notion of a 'sensible object,' to quote Newton's phrase. We may expand Newton's phrase, and state that the common sense of mankind conceives that all its notions ultimately refer to actual entities, or as Newton terms them, 'sensible objects.' Newton, basing himself upon current physical notions, conceived 'sensible objects' to be the material bodies to which the science of dynamics applies. He was then left with the antithesis between 'sensible objects'

and empty space. Newton, indeed, as a private opinion, conjectured that there is a material medium pervading space. But he also held that there *might* not be such a medium. For him the notion 'empty space'—that is, mere spatiality—had sense, conceived as an independent actual existence 'from infinity to infinity.' In this he differed from Descartes. Modern physics sides with Descartes. It has introduced the notion of the 'physical field.' Also the latest speculations tend to remove the sharp distinction between the 'occupied' portions of the field and the 'unoccupied' portion. Further, in these lectures (cf. Ch. III of Part II), a distinction is introduced, not explicitly in the mind either of the 'vulgar' or of Newton. This distinction is that between (i) an actual entity, (ii) an enduring object, (iii) a corpuscular society, (iv) a non-corpuscular society, (v) a non-social nexus. A non-social nexus is what answers to the notion of 'chaos.' The extensive continuum is that general relational element in experience whereby the actual entities experienced, and that unit experience itself, are united in the solidarity of one common world. The actual entities atomize it, and thereby make real what was antecedently merely potential. The atomization of the extensive continuum is also its temporalization; that is to say, it is the process of the becoming of actuality into what in itself is merely potential. The systematic scheme, in its completeness embracing the actual past and the potential future, is prehended in the positive experience of each actual entity. In this sense, it is Kant's 'form of intuition'; but it is derived from the actual world *qua datum,* and thus is not 'pure' in Kant's sense of that term. It is not productive of the ordered world, but derivative from it. The prehension of this scheme is one more example that actual fact includes in its own constitution real potentiality which is referent beyond itself. The former example is 'appetition.'

SECTION IV

Newton in his description of space and time has confused what is 'real' potentiality with what is actual fact. He has thereby been led to diverge from the judgment of 'the vulgar' who 'conceive those quantities under no other notions but from the relation they bear to sensible objects.' The philosophy of organism starts by agreeing with 'the vulgar' except that the term 'sensible object' is replaced by 'actual entity'; so as to free our notions from participation in an epistemological theory as to sense-perception. When we further consider how

to adjust Newton's other descriptions to the organic theory, the surprising fact emerges that we must identify the atomized quantum of extension correlative to an actual entity, with Newton's absolute place and absolute duration. Newton's proof that motion does not apply to absolute place, which in its nature is immovable, also holds. Thus an actual entity never moves: it is where it is and what it is. In order to emphasize this characteristic by a phrase connecting the notion of 'actual entity' more closely with our ordinary habits of thought, I will also use the term 'actual occasion' in the place of the term 'actual entity.' Thus the actual world is built up of actual occasions; and by the ontological principle whatever things there are in any sense of 'existence,' are derived by abstraction from actual occasions. I shall use the term 'event' in the more general sense of a nexus of actual occasions, inter-related in some determinate fashion in one extensive quantum. An actual occasion is the limiting type of an event with only one member.

It is quite obvious that meanings have to be found for the notions of 'motion' and of 'moving bodies.' For the present, this enquiry must be postponed to a later chapter (cf. Part IV and also Ch. III of this Part). It is sufficient to say that a molecule in the sense of a moving body, with a history of local change, is not an actual occasion; it must therefore be some kind of nexus of actual occasions. In this sense it is an event, but not an actual occasion. The fundamental meaning of the notion of 'change' is 'the difference between actual occasions comprised in some determinate event.'

A further elucidation of the status of the extensive continuum in the organic philosophy is obtained by comparison with Descartes' doctrine of material bodies. It is at once evident that the organic theory is much closer to Descartes' views than to Newton's. On this topic Spinoza is practically a logical systematization of Descartes, purging him of inconsistencies. But this attainment of logical coherence is obtained by emphasizing just those elements in Descartes which the philosophy of organism rejects. In this respect, Spinoza performs the same office for Descartes that Hume does for Locke. The philosophy of organism may be conceived as a recurrence to Descartes and to Locke, in respect to just those elements in their philosophies which are usually rejected by reason of their inconsistency with the elements which their successors developed. Thus the philosophy of organism is pluralistic in contrast with Spinoza's

monism; and is a doctrine of experience prehending actualities, in contrast with Hume's sensationalist phenomenalism.

First let us recur to Descartes at the stage of thought antecedent to his disastrous classification of substances into two species, bodily substance and mental substance. At the beginning of *Meditation I,* he writes:

'For example, there is the fact that I am here, seated by the fire, attired in a dressing gown, having this paper in my hands and other similar matters. And how could I deny that these hands and this body are mine, were it not perhaps that I compare myself to certain persons, devoid of sense. . . . But they are mad, and I should not be any less insane were I to follow examples so extravagant.

'At the same time I must remember that I am a man, and that consequently I am in the habit of sleeping, and in my dreams representing to myself the same things or sometimes even less probable things, than do those who are insane in their waking moments. . . . At the same time we must at least confess that the things which are represented to us in sleep are like painted representations which can only have been formed as the counterparts of something real and true [*ad similitudinem rerum verarum*], and that in this way those general things at least, i.e. eyes, a head, hands, and a whole body, are not imaginary things, but things really existent. . . . And for the same reason, although these general things, to wit [a body],* eyes, a head, hands, and such like may be imaginary, we are bound at the same time to confess that there are at least some other objects yet more simple and more universal, which are real and true [*vera esse*]; and of these just in the same way as with certain real colours, all these images of things which dwell in our thoughts, whether true and real or false and fantastic, are formed.

'To such a class of things pertains corporeal nature in general, and its extension, the figure of extended things, their quantity or magnitude and number, as also the place in which they are, the time which measures their duration, and so on. . . .'

In *Meditation II,* after a slight recapitulation, he continues, speaking of God: 'Then without doubt I exist also if he deceives me, and let him deceive me as much as he will, he can never cause me to be nothing so long as I think that I am something. So that after having

* Haldane and Ross enclose in square brackets phrases appearing in the French version, and not in the Latin. I have compared with the Latin.

reflected well and carefully examined all things, we must come to the definite conclusion that this proposition: "I am, I exist," is necessarily true each time that I pronounce it, or that I mentally conceive it.'

At the end of the quotation from *Meditation I,* Descartes uses the phrase *res vera* in the same sense as that in which I have used the term 'actual.' It means 'existence' in the fullest sense of that term, beyond which there is no other. Descartes, indeed, would ascribe to God 'existence' in a generically different sense. In the philosophy of organism, as here developed, God's existence is not generically different from that of other actual entities, except that he is 'primordial' in a sense to be gradually explained.

Descartes does not explicitly frame the definition of actuality in terms of the ontological principle, as given in Section III of this chapter, that actual occasions form the ground from which all other types of existence are derivative and abstracted; but he practically formulates an equivalent in subject-predicate phraseology, when he writes: 'For this reason, when we perceive any attribute, we therefore conclude that some existing thing or substance to which it may be attributed, is necessarily present.' * For Descartes the word 'substance' is the equivalent of my phrase 'actual occasion.' I refrain from the term 'substance,' for one reason because it suggests the subject-predicate notion; and for another reason because Descartes and Locke permit their substances to undergo adventures of changing qualifications, and thereby create difficulties.

In the quotation from the second *Meditation:* ' "I am, I exist," is necessarily true each time that I pronounce it, or that I mentally conceive it.' Descartes adopts the position that an act of experience is the primary type of actual occasion. But in his subsequent developments he assumes that his mental substances endure change. Here he goes beyond his argument. For each time he pronounces 'I am, I exist,' the actual occasion, which is the ego, is different; and the 'he' which is common to the two egos is an eternal object or, alternatively, the nexus of successive occasions. Also in the quotation from the first *Meditation* he begins by appealing to an act of experience—'I am here, seated by the fire. . . .' He then associates this act of experience with his body—'these hands and body are mine.' He then finally appeals for some final notion of actual entities in the remarkable sentence: 'And for the same reason, although these general things,

* *Principles of Philosophy,* Part I, 52.

to wit, a body, eyes, a head, hands, and such like, may be imaginary, we are bound at the same time to confess that there are at least some other objects yet more simple and more universal, which are real and true; and of these . . . all these images of things which dwell in our thoughts whether true and real or false and fantastic, are formed.'

Notice the peculiarly intimate association with immediate experience which Descartes claims for his body, an association beyond the mere sense-perception of the contemporary world—'these hands and feet are mine.' In the philosophy of organism this immediate association is the recognition of them as distinguishable data whose formal constitutions are immediately felt in the origination of experience. In this function the animal body does not differ in principle from the rest of the past actual world; but it does differ in an intimacy of association by reason of which its spatial and temporal connections obtain some definition in the experience of the subject. What is vague for the rest of the world has obtained some additional measure of distinctness for the bodily organs. But, in principle, it would be equally true to say, 'The actual world is mine.'

Descartes also asserts that 'objects yet more simple and more universal, which are real and true' are what the 'images of things which dwell in our thoughts' are formed of. This does not seem to accord with his theory of perception, of a later date, stated in his *Principles,* Part IV, 196, 197, 198. In the later theory the emphasis is on the *judicium,* in the sense of 'inference,' and not in the sense of *inspectio* of *realitas objectiva.* But it does accord with the organic theory, that the objectifications of other actual occasions form the given data from which an actual occasion originates. He has also brought the body into its immediate association with the act of experience. Descartes, with Newton, assumes that the extensive continuum is actual in the full sense of being an actual entity. But he refrains from the additional material bodies which Newton provides. Also in his efforts to guard his representative 'ideas' from the fatal gap between mental symbol and actuality symbolized, he practically, in some sentences, expresses the doctrine of objectification here put forward. Thus: 'Hence the idea of the sun will be the sun itself existing in the mind, not indeed formally, as it exists in the sky, but objectively, i.e. in the way in which objects are wont to exist in the mind; and this mode of being is truly much less perfect than that in which things exist

outside the mind, but it is not on that account mere nothing, as I have already said.' *

Both Descartes and Locke, in order to close the gap between idea representing and 'actual entity represented,' require this doctrine of 'the sun itself existing in the mind.' But though, as in this passage, they at times casually state it in order to push aside the epistemological difficulty, they neither of them live up to these admissions. They relapse into the tacit presupposition of the mind with its private ideas which are in fact qualities without intelligible connection with the entities represented.

But if we take the doctrine of objectification seriously, the extensive continuum at once becomes the primary factor in objectification. It provides the general scheme of extensive perspective which is exhibited in all the mutual objectifications by which actual entities prehend each other. Thus in itself, the extensive continuum is a scheme of real potentiality which must find exemplification in the mutual prehension of all actual entities. It also finds exemplification in each actual entity considered 'formally.' In this sense, actual entities are extensive, since they arise out of a potentiality for division, which in actual fact is not divided (cf. Part IV). It is for this reason, as stated above, that the phrase 'actual occasion' is used in the place of 'actual entity.'

Descartes' doctrine of the physical world as exhibiting an extensive plenum of actual entities is practically the same as the 'organic' doctrine. But Descartes' bodies have to move, and this presupposition introduces new obscurities. It is exactly at this point that Newton provides a clear conception in comparison with that of Descartes. In the 'organic' doctrine, motion is not attributable to an actual occasion.

In the 'organic' theory (i) there is only one type of temporal actual entity; (ii) each such actual entity is extensive; (iii) from the standpoint of any one actual entity, the 'given' actual world is a nexus of actual entities, transforming the potentiality of the extensive scheme into a plenum of actual occasions; (iv) in this plenum, motion cannot be significantly attributed to any actual occasion; (v) the plenum is continuous in respect to the potentiality from which it arises, but each actual entity is atomic; (vi) the term 'actual occasion' is used

* Cf. *Reply to Objections I.* I have already quoted this passage in my *Science and the Modern World,* note to Ch. IV.

synonymously with 'actual entity'; but chiefly when its character of extensiveness has some direct relevance to the discussion, either extensiveness in the form of temporal extensiveness, that is to say 'duration,' or extensiveness in the form of spatial extension, or in the more complete signification of spatio-temporal extensiveness.

SECTION V

The baseless metaphysical doctrine of 'undifferentiated endurance' is a subordinate derivative from the misapprehension of the proper character of the extensive scheme.

In our perception of the contemporary world via presentational immediacy, nexūs of actual entities are objectified for the percipient under the perspective of their characters of extensive continuity. In the perception of a contemporary stone, for example, the separate individuality of each actual entity in the nexus constituting the stone is merged into the unity of the extensive plenum, which for Descartes and for common sense, *is* the stone. The complete objectification is effected by the generic extensive perspective of the stone, specialized into the specific perspective of some sense-datum, such as some definite colour, for example. Thus the immediate percept assumes the character of the quiet undifferentiated endurance of the material stone, perceived by means of its quality of colour. This basic notion dominates language, and haunts both science and philosophy. Further, by an unfortunate application of the excellent maxim, that our conjectural explanation should always proceed by the utilization of a *vera causa,* whenever science or philosophy has ventured to extrapolate beyond the limits of the immediate deliverance of direct perception, a satisfactory explanation has always complied with the condition that substances with undifferentiated endurance of essential attributes be produced, and that activity be explained as the occasional modification of their accidental qualities and relations. Thus the imaginations of men are dominated by the quiet extensive stone with its relationships of positions, and its quality of colour—relationships and qualities which occasionally change. The stone, thus interpreted, guarantees the *vera causa,* and conjectural explanations in science and philosophy follow its model.

Thus in framing cosmological theory, the notion of continuous stuff with permanent attributes, enduring without differentiation, and retaining its self-identity through any stretch of time however small

or large, has been fundamental. The stuff undergoes change in respect to accidental qualities and relations; but it is numerically self-identical in its character of one actual entity throughout its accidental adventures. The admission of this fundamental metaphysical concept has wrecked the various systems of pluralistic realism.

This metaphysical concept has formed the basis of scientific materialism. For example, when the activities associated with so-called empty space required scientific formulation, the scientists of the nineteenth century produced the materialistic ether as the ultimate substratum whose accidental adventures constituted these activities.

But the interpretation of the stone, on which the whole concept is based, has proved to be entirely mistaken. In the first place, from the seventeenth century onwards the notion of the simple inherence of the colour in the stone has had to be given up. This introduces the further difficulty that it is the colour which is extended and only inferentially the stone, since now we have had to separate the colour from the stone. Secondly, the molecular theory has robbed the stone of its continuity, of its unity, and of its passiveness. The stone is now conceived as a society of separate molecules in violent agitation. But the metaphysical concepts, which had their origin in a mistake about the stone, were now applied to the individual molecules. Each atom was still a stuff which retained its self-identity and its essential attributes in any portion of time—however short, and however long—provided that it did not perish. The notion of the undifferentiated endurance of substances with essential attributes and with accidental adventure was still applied. This is the root doctrine of materialism: the substance, thus conceived, is the ultimate actual entity.

But this materialistic concept has proved to be as mistaken for the atom as it was for the stone. The atom is only explicable as a society with activities involving rhythms with their definite periods. Again the concept shifted its application: protons and electrons were conceived as materialistic electric charges whose activities could be construed as locomotive adventures. We are now approaching the limits of any reasonable certainty in our scientific knowledge; but again there is evidence that the concept may be mistaken. The mysterious quanta of energy have made their appearance, derived, as it would seem, from the recesses of protons, or of electrons. Still worse for the concept, these quanta seem to dissolve into the vibrations of light.

Also the material of the stars seems to be wasting itself in the production of the vibrations.

Further, the quanta of energy are associated by a simple law with the periodic rhythms which we detect in the molecules. Thus the quanta are, themselves, in their own nature, somehow vibratory; but they emanate from the protons and electrons. Thus there is every reason to believe that rhythmic periods cannot be dissociated from the protonic and electronic entities.

The same concept has been applied in other connections where it even more obviously fails. It is said that 'men are rational.' This is palpably false: they are only intermittently rational—merely liable to rationality. Again the phrase 'Socrates is mortal' is only another way of saying that 'perhaps he will die.' The intellect of Socrates is intermittent: he occasionally sleeps and he can be drugged or stunned.

The simple notion of an enduring substance sustaining persistent qualities, either essentially or accidentally, expresses a useful abstract for many purposes of life. But whenever we try to use it as a fundamental statement of the nature of things, it proves itself mistaken. It arose from a mistake and has never succeeded in any of its applications. But it has had one success: it has entrenched itself in language, in Aristotelian logic, and in metaphysics. For its employment in language and in logic, there is—as stated above—a sound pragmatic defence. But in metaphysics the concept is sheer error. This error does not consist in the employment of the word 'substance'; but in the employment of the notion of an actual entity which is characterized by essential qualities, and remains numerically one amidst the changes of accidental relations and of accidental qualities. The contrary doctrine is that an actual entity never changes, and that it is the outcome of whatever can be ascribed to it in the way of quality or relationship. There then remain two alternatives for philosophy: (i) a monistic universe with the illusion of change; and (ii) a pluralistic universe in which 'change' means the diversities among the actual entities which belong to some one society of a definite type.

SECTION VI

We can now, in a preliminary way, summarize some of the agreements and disagreements between the philosophy of organism and the

seventeenth-century founders of the modern philosophic and scientific traditions.

It is the basis of any realistic philosophy, that in perception there is a disclosure of objectified data, which are known as having a community with the immediate experience for which they are data. This 'community' is a community of common activity involving mutual implication. This premise is asserted as a primary fact, implicitly assumed in every detail of our organization of life. It is implicitly asserted by Locke in his statement (II, XXIII, 7, heading), 'Power, a great part of our complex ideas of substance.' The philosophy of organism extends the Cartesian subjectivism by affirming the 'ontological principle' and by construing it as the definition of 'actuality.' This amounts to the assumption that each actual entity is a locus for the universe. Accordingly Descartes' other statement, that every attribute requires a substance is merely a special, limited example of this more general principle.

Newton, in his treatment of space, transforms potentiality into actual fact, that is to say, into a creature, instead of a datum for creatures. According to the philosophy of organism, the extensive space-time continuum is the fundamental aspect of the limitation laid upon abstract potentiality by the actual world. A more complete rendering of this limited, 'real' potentiality is the 'physical field.' A new creation has to arise from the actual world as much as from pure potentiality: it arises from the total universe and not solely from its mere abstract elements. It also adds to that universe. Thus every actual entity springs from *that* universe which there *is for it*. Causation is nothing else than one outcome of the principle that every actual entity has to house *its* actual world.

According to Newton, a portion of space cannot move. We have to ask how this truth, obvious from Newton's point of view, takes shape in the organic theory. Instead of a region of space, we should consider a bit of the physical field. This bit, expressing one way in which the actual world involves the potentiality for a new creation, acquires the unity of an actual entity. The physical field is, in this way, atomized with definite divisions: it becomes a 'nexus' of actualities. Such a quantum (i.e. each actual division) of the extensive continuum is the primary phase of a creature. This quantum is constituted by its totality of relationships and cannot move. Also the creature cannot have any external adventures, but only the internal adventure of becoming. Its birth is its end.

This is a theory of monads; but it differs from Leibniz's in that his monads change. In the organic theory, they merely *become*. Each monadic creature is a mode of the process of 'feeling' the world, of housing the world in one unit of complex feeling, in every way determinate. Such a unit is an 'actual occasion'; it is the ultimate creature derivative from the creative process.

The term 'event' is used in a more general sense. An event is a nexus of actual occasions inter-related in some determinate fashion in some extensive quantum: it is either a nexus in its formal completeness, or it is an objectified nexus. One actual occasion is a limiting type of event. The most general sense of the meaning of change is 'the differences between actual occasions in one event.' For example, a molecule is a historic route of actual occasions; and such a route is an 'event.' Now the motion of the molecule is nothing else than the differences between the successive occasions of its life-history in respect to the extensive quanta from which they arise; and the changes in the molecule are the consequential differences in the actual occasions.

The organic doctrine is closer to Descartes than to Newton. Also it is close to Spinoza; but Spinoza bases his philosophy upon the monistic substance, of which the actual occasions are inferior modes. The philosophy of organism inverts this point of view.

As to the direct knowledge of the actual world as a datum for the immediacy of feeling, we first refer to Descartes in *Meditation I,* 'These hands and this body are *mine*'; also to Hume in his many assertions of the type, we see *with our eyes.* Such statements witness to direct knowledge of the antecedent functioning of the body in sense-perception. Both agree—though Hume more explicitly—that sense-perception of the contemporary world is accompanied by perception of the 'withness' of the body. It is this withness that makes the body the starting point for our knowledge of the circumambient world. We find here our direct knowledge of 'causal efficacy.' Hume and Descartes in their theory of direct perceptive knowledge dropped out this withness of the body; and thus confined perception to presentational immediacy. Santayana, in his doctrine of 'animal faith,' practically agrees with Hume and Descartes as to this withness of the actual world, including the body. Santayana also excludes our knowledge of it from givenness. Descartes calls it a certain kind of 'understanding'; Santayana calls it 'animal faith' provoked by 'shock'; and Hume calls it 'practice.'

But we must—to avoid 'solipsism of the present moment'—include in direct perception something more than presentational immediacy. For the organic theory, the most primitive perception is 'feeling the body as functioning.' This is a feeling of the world in the past; it is the inheritance of the world as a complex of feeling; namely, it is the feeling of derived feelings. The later, sophisticated perception is 'feeling the contemporary world.' Even this presentational immediacy begins with sense-presentation of the contemporary body. The body, however, is only a peculiarly intimate bit of the world. Just as Descartes said, 'this body is mine'; so he should have said, 'this actual world is mine.' My process of 'being myself' is my origination from my possession of the world.

It is obvious that there arise the questions of comparative relevance and of comparative vagueness, which constitute the perspective of the world. For example, the body is that portion of the world where, in causal perception, there is some distinct separation of regions. There is not, in causal perception, this distinctness for the past world external to the body. We eke out our knowledge by 'symbolic transference' from causal perception to sense-presentation, and vice versa.

Those realists, who base themselves upon the notion of substance, do not get away from the notion of actual entities which move and change. From the point of view of the philosophy of organism, there is great merit in Newton's immovable receptacles. But for Newton they are eternal. Locke's notion of time hits the mark better: time is 'perpetually perishing.' In the organic philosophy an actual entity has 'perished' when it is complete. The pragmatic use of the actual entity, constituting its static life, lies in the future. The creature perishes *and* is immortal. The actual entities beyond it can say, 'It is mine.' But the possession imposes conformation.

This conception of an actual entity in the fluent world is little more than an expansion of a sentence in the *Timaeus:* * 'But that which is conceived by opinion with the help of sensation and without reason, is always in the process of becoming and perishing and never really is.' Bergson, in his protest against 'spatialization,' is only echoing Plato's phrase 'and never really is.'

* Jowett's translation. Professor A. E. Taylor in his *Commentary on the Timaeus* renders the word δόξα by 'belief' or 'judgment' in the place of Jowett's word 'opinion.' Taylor's translation brings out the Platonic influence in Descartes' *Meditations,* namely Plato's δόξα is the Cartesian *judicium.*

CHAPTER III *THE ORDER OF NATURE*

SECTION I

In this, and in the next chapter, among modern philosophers we are chiefly concerned with Hume and with Kant, and among ancient philosophers with the *Timaeus* of Plato. These chapters are concerned with the allied problems of 'order in the universe,' of 'induction,' and of 'general truths.' The present chapter is wholly concerned with the topic of 'order.' For the organic doctrine the problem of order assumes primary importance. No actual entity can rise beyond what the actual world as a datum from its standpoint—*its* actual world—allows it to be. Each such entity arises from a primary phase of the concrescence of objectifications which are in some respects settled: the basis of its experience is 'given.' Now the correlative of 'order' is 'disorder.' There can be no peculiar meaning in the notion of 'order' unless this contrast holds. Apart from it, 'order' must be a synonym for 'givenness.' But 'order' means more than 'givenness,' though it presupposes 'givenness,' 'disorder' is also 'given.' Each actual entity requires a totality of 'givenness,' and each totality of 'givenness' attains its measure of 'order.'

Four grounds of 'order' at once emerge:

(i) That 'order' in the actual world is differentiated from mere 'givenness' by introduction of adaptation for the attainment of an end.

(ii) That this end is concerned with the gradations of intensity in the satisfactions of actual entities (members of the nexus) in whose formal constitutions the nexus (i.e. antecedent members of the nexus) in question is objectified.

(iii) That the heightening of intensity arises from order such that the multiplicity of components in the nexus can enter explicit feeling as *contrasts,* and are not dismissed into negative prehensions as *incompatibilities.*

(iv) That 'intensity' in the *formal constitution* of a subject-superject involves 'appetition' in its *objective* functioning as superject.

'Order' is a mere generic term: there can only be some definite specific 'order,' not merely 'order' in the vague. Thus every definite total phase of 'givenness' involves a reference to that specific 'order'

which is its dominant ideal, and involves the specific 'disorder' due to its inclusion of 'given' components which exclude the attainment of the full ideal. The attainment is partial, and thus there is 'disorder'; but there is some attainment, and thus there is some 'order.' There is not just one ideal 'order' which all actual entities should attain and fail to attain. In each case there is an ideal peculiar to each particular actual entity, and arising from the dominant components in its phase of 'givenness.' This notion of 'dominance' will have to be discussed later in connection with the notion of the systematic character of a 'cosmic epoch' and of the subordinate systematic characters of 'societies' included in a cosmic epoch. The notion of one ideal arises from the disastrous overmoralisation of thought under the influence of fanaticism, or pedantry. The notion of a dominant ideal peculiar to each actual entity is Platonic.

It is notable that no biological science has been able to express itself apart from phraseology which is meaningless unless it refers to ideals proper to the organism in question. This aspect of the universe impressed itself on that great biologist and philosopher, Aristotle. His philosophy led to a wild overstressing of the notion of final causes during the Christian Middle Ages; and thence, by a reaction, to the correlative overstressing of the notion of 'efficient causes' during the modern scientific period. One task of a sound metaphysics is to exhibit final and efficient causes in their proper relation to each other. The necessity and the difficulty of this task are stressed by Hume in his *Dialogues Concerning Natural Religion.*

Thus the notion of 'order' is bound up with the notion of an actual entity as involving an attainment which is a specific satisfaction. This satisfaction is the attainment of something individual to the entity in question. It cannot be construed as a component contributing to its own concrescence; it is the ultimate fact, individual to the entity. The notion of 'satisfaction' is the notion of the 'entity as concrete' abstracted from the 'process of concrescence'; it is the outcome separated from the process, thereby losing the actuality of the atomic entity, which is both process and outcome. 'Satisfaction' provides the individual element in the composition of the actual entity—that element which has led to the definition of substance as 'requiring nothing but itself in order to exist.' But the 'satisfaction' is the 'superject' rather than the 'substance' or the 'subject.' It closes up the entity; and yet is the superject adding its character to the

creativity whereby there is a becoming of entities superseding the one in question. The 'formal' reality of the actuality in question belongs to its process of concrescence and not to its 'satisfaction.' This is the sense in which the philosophy of organism interprets Plato's phrase 'and never really is'; for the superject can only be interpreted in terms of its 'objective immortality.'

'Satisfaction' is a generic term: there are specific differences between the 'satisfactions' of different entities, including gradations of intensity. These specific differences can only be expressed by the analysis of the components in the concrescence out of which the actual entity arises. The intensity of satisfaction is promoted by the 'order' in the phases from which concrescence arises and through which it passes; it is enfeebled by the 'disorder.' The components in the concrescence are thus 'values' contributory to the 'satisfaction.' The concrescence is thus the building up of a determinate 'satisfaction,' which constitutes the completion of the actual togetherness of the discrete components. The process of concrescence terminates with the attainment of a fully *determinate* 'satisfaction'; and the creativity thereby passes over into the 'given' primary phase for the concrescence of other actual entities. This transcendence is thereby established when there is attainment of *determinate* 'satisfaction' completing the antecedent entity. Completion is the perishing of immediacy: 'It never really is.'

No actual entity can be conscious of its own satisfaction; for such knowledge would be a component in the process, and would thereby alter the satisfaction. In respect to the entity in question the satisfaction can only be considered as a creative determination, by which the objectifications of the entity beyond itself are settled. In other words, the 'satisfaction' of an entity can only be discussed in terms of the usefulness of that entity. It is a qualification of creativity. The tone of feeling embodied in this satisfaction passes into the world beyond, by reason of these objectifications. The world is self-creative; and the actual entity as self-creating creature passes into its immortal function of part-creator of the transcendent world. In its self-creation the actual entity is guided by its ideal of itself as individual satisfaction and as transcendent creator. The enjoyment of this ideal is the 'subjective aim,' by reason of which the actual entity is a determinate process.

This subjective aim is not primarily intellectual; it is the lure for

feeling. This lure for feeling is the germ of mind. Here I am using the term 'mind' to mean the complex of mental operations involved in the constitution of an actual entity. Mental operations do not necessarily involve consciousness. The concrescence, absorbing the derived data into immediate privacy, consists in mating the data with ways of feeling provocative of the private synthesis. These subjective ways of feeling are not merely receptive of the data as alien facts; they clothe the dry bones with the flesh of a real being, emotional, purposive, appreciative. The miracle of creation is described in the vision of the prophet Ezekiel: "So I prophesied as he commanded me, and the breath came into them, and they lived and stood up upon their feet, an exceeding great army." *

The breath of feeling which creates a new individual fact has an origination not wholly traceable to the mere data. It conforms to the data, in that it feels the data. But the *how* of feeling, though it is germane to the data, is not fully determined by the data. The relevant feeling is not settled, as to its inclusions or exclusions of 'subjective form,' by the data about which the feeling is concerned. The concrescent process is the elimination of these indeterminations of subjective forms. The quality of feeling has to be definite in respect to the eternal objects with which feeling clothes itself in its self-definition. It is a mode of ingression of eternal objects into the actual occasion. But this self-definition is analysable into two phases. First, the conceptual ingression of the eternal objects in the double rôle of being germane to the data and of being potentials for the physical feeling. This is the ingression of an eternal object in the rôle of a conceptual lure for feeling. The second phase is the admission of the lure into the reality of feeling, or its rejection from this reality. The *relevance* of an eternal object in its rôle of lure is a fact inherent in the data. In this sense the eternal object is a constituent of the 'objective lure.' But the admission into, or rejection from, reality of conceptual feeling is the originative decision of the actual occasion. In this sense an actual occasion is *causa sui*. The subjective forms of the prehensions in one phase of concrescence control the specific integrations of prehensions in later phases of that concrescence.

An example of the lure for feeling is given by Hume himself. In the first section of his *Treatise* he lays down the proposition, 'That all our simple ideas in their first appearance, are derived from simple

* Cf. Ezekiel, xxxvii.

impressions, which are correspondent to them, and which they exactly represent.' It must be remembered that in the organic philosophy the 'data of objectifications' are the nearest analogue to Hume's 'simple impressions.' Thus, modifying Hume's principle, the only lure to conceptual feeling is an exact conformation to the qualities realized in the objectified actualities. But Hume (*loc. cit.*) notes an exception which carries with it the exact principle which has just been laid down, namely, the principle of relevant potentials, unrealized in the datum and yet constituent of an 'objective lure' by proximity to the datum. The point is that 'order' in the actual world introduces a derivative 'order' among eternal objects. Hume writes: 'There is however, one contradictory phenomenon, which may prove that it is not absolutely impossible for ideas to go before their correspondent impressions. I believe it will readily be allowed, that the several distinct ideas of colours, which enter by the eyes, of those of sounds, which are conveyed by the hearing, are really different from each other, though, at the same time, resembling. Now, if this be true of different colours, it must be no less so of the different shades of the same colour, that each of them produces a distinct idea independent of the rest. . . . Suppose, therefore, a person to have enjoyed his sight for thirty years, and to have become perfectly well acquainted with colours of all kinds, excepting one particular shade of blue, for instance, which it has never been his fortune to meet with. Let all the different shades of that colour, except that single one, be placed before him, descending gradually from the deepest to the lightest; it is plain, that he will perceive a blank, where that shade is wanting, and will be sensible that there is a greater distance in that place, between the contiguous colours, than in any other. Now I ask, whether it is possible for him, from his own imagination, to supply this deficiency, and to raise up to himself the idea of that particular shade, though it had never been conveyed to him by his senses. I believe there are few but will be of opinion that he can; and this may serve as a proof, that the simple ideas are not always derived from the correspondent impressions; though the instance is so particular and singular, that it is scarce worth our observing, and does not merit that, for it alone, we should alter our general maxim.'

This passage requires no comment, except for its final clause. Hume puts the 'instance' aside as being 'particular and singular'; it is exactly this estimate which is challenged by the philosophy of

organism. The analysis of concrescence, here adopted, conceives that there is an origination of conceptual feeling, admitting or rejecting whatever is apt for feeling by reason of its germaneness to the basic data. The gradation of eternal objects in respect to this germaneness is the 'objective lure' for feeling; the concrescent process admits a selection from this 'objective lure' into subjective efficiency. This is the subjective 'ideal of itself' which guides the process. Also the basic data are constituted by the actual world which 'belongs to' that instance of concrescent process. Feelings are 'vectors'; for they feel what is *there* and transform it into what is *here*.

The term 'potential difference' is an old one in physical science; and recently it has been introduced in physiology with a meaning diverse from, though generically allied to, its older meaning in physics. The ultimate fact in the constitution of an actual entity which suggests this term is the objective lure for feeling. In the comparison of two actual entities, the contrast between their objective lures is their 'potential difference'; and all other uses of this phrase are abstractions derivative from this ultimate meaning.

The 'objectifications' of the actual entities in the actual world, relative to a definite actual entity, constitute the efficient causes out of which *that* actual entity arises; the 'subjective aim' at 'satisfaction' constitutes the final cause, or lure, whereby there is determinate concrescence; and that attained 'satisfaction' remains as an element in the content of creative purpose. There is, in this way, transcendence of the creativity; and this transcendence effects determinate objectifications for the renewal of the process in the concrescence of actualities beyond that satisfied superject.

Thus an actual entity has a three-fold character: (i) it has the character 'given' for it by the past; (ii) it has the subjective character aimed at in its process of concrescence; (iii) it has the superjective character, which is the pragmatic value of its specific satisfaction qualifying the transcendent creativity.

In the case of the primordial actual entity, which is God, there is no past. Thus the ideal realization of conceptual feeling takes the precedence. God differs from other actual entities in the fact that Hume's principle, of the derivate character of conceptual feelings, does not hold for him. There is still, however, the same threefold character: (i) The 'primordial nature' of God is the concrescence of a unity of conceptual feelings, including among their data all eternal

objects. The concrescence is directed by the subjective aim, that the subjective forms of the feelings shall be such as to constitute the eternal objects into relevant lures of feeling severally appropriate for all realizable basic conditions. (ii) The 'consequent nature' of God is the physical prehension by God of the actualities of the evolving universe. This primordial nature directs such perspectives of objectification that each novel actuality in the temporal world contributes such elements as it can to a realization in God free from inhibitions of intensity by reason of discordance. (iii) The 'superjective' nature of God is the character of the pragmatic value of his specific satisfaction qualifying the transcendent creativity in the various temporal instances.

This is the conception of God, according to which he is considered as the outcome of creativity, as the foundation of order, and as the goal towards novelty. 'Order' and 'novelty' are but the instruments of his subjective aim which is the intensification of 'formal immediacy.' It is to be noted that every actual entity, including God, is something individual for its own sake; and thereby transcends the rest of actuality. And also it is to be noted that every actual entity, including God, is a creature transcended by the creativity which it qualifies. A temporal occasion in respect to the second element of its character, and God in respect to the first element of his character satisfy Spinoza's definition of substance, that it is *causa sui*. To be *causa sui* means that the process of concrescence is its own reason for the decision in respect to the qualitative clothing of feelings. It is finally responsible for the decision by which any lure for feeling is admitted to efficiency. The freedom inherent in the universe is constituted by this element of self-causation.

In the subsequent discussion, 'actual entity' will be taken to mean a conditioned actual entity of the temporal world, unless God is expressly included in the discussion. The term 'actual occasion' will always exclude God from its scope.

The philosophy of organism is the inversion of Kant's philosophy. *The Critique of Pure Reason* describes the process by which subjective data pass into the appearance of an objective world. The philosophy of organism seeks to describe how objective data pass into subjective satisfaction, and how order in the objective data provides intensity in the subjective satisfaction. For Kant, the world emerges from the subject; for the philosophy of organism, the sub-

ject emerges from the world—a 'superject' rather than a 'subject.' The word 'object' thus means an entity which is a potentiality for being a component in feeling; and the word 'subject' means the entity constituted by the process of feeling, and including this process. The feeler is the unity emergent from its own feelings; and feelings are the details of the process intermediary between this unity and its many data. The data are the potentials for feeling; that is to say, they are objects. The process is the elimination of indeterminateness of feeling from the unity of one subjective experience. The degree of order in the datum is measured by the degree of richness in the objective lure. The 'intensity' achieved belongs to the subjective form of the satisfaction.

SECTION II

It has been explained in the previous section that the notion of 'order' is primarily applicable to the objectified data for individual actual entities. It has been necessary to give a sketch of some categories applying to an actual entity in order to show how this can be the case. But there is a derivative sense of the term 'order,' which is more usually in our minds when we use that word. We speak of the 'order of nature,' meaning thereby the order reigning in that limited portion of the universe,* or even of the surface of the earth, which has come under our observation. We also speak of a man of orderly life, or of disorderly life. In any of these senses, the term 'order' evidently applies to the relations among themselves enjoyed by many actual entities which thereby form a society. The term 'society' will always be restricted to mean a nexus of actual entities which are 'ordered' among themselves in the sense to be explained in this section.† The point of a 'society,' as the term is here used, is that it is self-sustaining; in other words, that it is its own reason. Thus a society is more than a set of entities to which the same class-name applies: that is to say, it involves more than a merely mathematical conception of 'order.' To constitute a society, the class-name has got to apply to each member, by reason of genetic derivation from other members of that same society. The members of the society are alike

* Cf., *The Fitness of the Environment* (New York, Macmillan, 1913), and *The Order of Nature* (Harvard Univ. Press, 1917), and *Blood* (Harvard Univ. Press, 1928), Ch. I, all by Professor L. J. Henderson. These works are fundamental for any discussion of this subject.

† Also cf. Part I, Ch. III, Sec. II.

because, by reason of their common character, they impose on other members of the society the conditions which lead to that likeness.

This likeness * consists in the fact that (i) a certain element of 'form' is a contributory component to the individual satisfaction of each member of the society; and that (ii) the contribution by this element to the objectification of any one member of the society for prehension by other members promotes its analogous reproduction in the satisfactions of those other members. Thus a set of entities is a society (i) in virtue of a 'defining characteristic' shared by its members, and (ii) in virtue of the presence of the defining characteristic being due to the environment provided by the society itself.

For example, the life of man is an historic route of actual occasions which in a marked degree—to be discussed more fully later—inherit from each other. That set of occasions, dating from his first acquirement of the Greek language and including all those occasions up to his loss of any adequate knowledge of that language, constitutes a society in reference to knowledge of the Greek language. Such knowledge is a common characteristic inherited from occasion to occasion along the historic route. This example has purposely been chosen for its reference to a somewhat trivial element of order, viz. knowledge of the Greek language; a more important character of order would have been that complex character in virtue of which a man is considered to be the same enduring person from birth to death. Also in this instance the members of the society are arranged in a serial order by their genetic relations. Such a society is said † to possess 'personal order.'

Thus a society is, for each of its members, an environment with some element of order in it, persisting by reason of the genetic relations between its own members. Such an element of order is the order prevalent in the society.

But there is no society in isolation. Every society must be considered with its background of a wider environment of actual entities, which also contribute their objectifications to which the members of the society must conform. Thus the given contributions of the environment must at least be permissive of the self-sustenance of the society. Also, in proportion to its importance, this background must contribute those general characters which the more special character

* Cf. Part I, Ch. III, Sec. II.
† *Ibid.*

of the society presupposes for its members. But this means that the environment, together with the society in question, must form a larger society in respect to some more general characters than those defining the society from which we started. Thus we arrive at the principle that every society requires a social background, of which it is itself a part. In reference to any given society the world of actual entities is to be conceived as forming a background in layers of social order, the defining characteristics becoming wider and more general as we widen the background. Of course, the remote actualities of the background have their own specific characteristics of various types of social order. But such specific characteristics have become irrelevant for the society in question by reason of the inhibitions and attenuations introduced by discordance, that is to say, by disorder.

The metaphysical characteristics of an actual entity—in the proper general sense of 'metaphysics'—should be those which apply to all actual entities. It may be doubted whether such metaphysical concepts have ever been formulated in their strict purity—even taking into account the most general principles of logic and of mathematics. We have to confine ourselves to societies sufficiently wide, and yet such that their defining characteristics cannot safely be ascribed to all actual entities which have been or may be.

The causal laws which dominate a social environment are the product of the defining characteristic of that society. But the society is only efficient through its individual members. Thus in a society, the members can only exist by reason of the laws which dominate the society, and the laws only come into being by reason of the analogous characters of the members of the society.

But there is not any perfect attainment of an ideal order whereby the indefinite endurance of a society is secured. A society arises from disorder, where 'disorder' is defined by reference to the ideal for that society; the favourable background of a larger environment either itself decays, or ceases to favour the persistence of the society after some stage of growth: the society then ceases to reproduce its members, and finally after a stage of decay passes out of existence. Thus a system of 'laws' determining reproduction in some portion of the universe gradually rises into dominance; it has its stage of endurance, and passes out of existence with the decay of the society from which it emanates.

The arbitrary, as it were 'given,' elements in the laws of nature

warn us that we are in a special cosmic epoch. Here the phrase 'cosmic epoch' is used to mean that widest society of actual entities whose immediate relevance to ourselves is traceable. This epoch is characterised by electronic and protonic actual entities, and by yet more ultimate actual entities which can be dimly discerned in the quanta of energy. Maxwell's equations of the electromagnetic field hold sway by reason of the throngs of electrons and of protons. Also each electron is a society of electronic occasions, and each proton is a society of protonic occasions. These occasions are the reasons for the electromagnetic laws; but their capacity for reproduction, whereby each electron and each proton has a long life, and whereby new electrons and new protons come into being, is itself due to these same laws. But there is disorder in the sense that the laws are not perfectly obeyed, and that the reproduction is mingled with instances of failure. There is accordingly a gradual transition to new types of order, supervening upon a gradual rise into dominance on the part of the present natural laws.

But the arbitrary factors in the order of nature are not confined to the electromagnetic laws. There are the four dimensions of the spatio-temporal continuum, the geometrical axioms, even the mere dimensional character of the continuum—apart from the particular number of dimensions—and the fact of measurability. In later chapters * it will be evident that all these properties are additional to the more basic fact of extensiveness; also, that even extensiveness allows of grades of specialisation, arbitrarily one way or another, antecedently to the introduction of any of these additional notions. By this discovery the logical and mathematical investigations of the last two centuries are very relevant to philosophy. For the cosmological theories of Descartes, Newton, Locke, Hume, and Kant were framed in ignorance of that fact. Indeed, in the *Timaeus* Plato seems to be more aware of it than any of his successors, in the sense that he frames statements whose meaning is elucidated by its explicit recognition. These 'given' factors in geometry point to the wider society of which the electronic cosmic epoch constitutes a fragment.

A society does not in any sense create the complex of eternal objects which constitutes its defining characteristic. It only elicits that complex into importance for its members, and secures the reproduction of its membership. In speaking of a society—unless the context

* Cf. Part IV, *Process and Reality*.

expressly requires another interpretation—'membership' will always refer to the actual occasions, and not to subordinate enduring objects composed of actual occasions such as the life of an electron or of a man. These latter societies are the strands of 'personal' order which enter into many societies; generally speaking, whenever we are concerned with occupied space, we are dealing with this restricted type of corpuscular societies; and whenever we are thinking of the physical field in empty space, we are dealing with societies of the wider type. It seems as if the careers of waves of light illustrate the transition from the more restricted type to the wider type.

Thus our cosmic epoch is to be conceived primarily as a society of electromagnetic occasions, including electronic and protonic occasions, and only occasionally—for the sake of brevity in statement—as a society of electrons and protons. There is the same distinction between thinking of an army either as a class of men, or as a class of regiments.

SECTION III

Thus the physical relations, the geometrical relations of measurement, the dimensional relations, and the various grades of extensive relations, involved in the physical and geometrical theory of nature, are derivative from a series of societies of increasing width of prevalence, the more special societies being included in the wider societies. This situation constitutes the physical and geometrical order of nature. Beyond these societies there is disorder, where 'disorder' is a relative term expressing the lack of importance possessed by the defining characteristics of the societies in question beyond their own bounds. When those societies decay, it will not mean that their defining characteristics cease to exist; but that they lapse into unimportance for the actual entities in question. The term 'disorder' refers to a society only partially influential in impressing its characteristics in the form of prevalent laws. This doctrine, that order is a social product, appears in modern science as the statistical theory of the laws of nature, and in the emphasis on genetic relation.

But there may evidently be a state in which there are no prevalent societies securing any congruent unity of effect. This is a state of chaotic disorder; it is disorder approaching an absolute sense of that term. In such an ideal state, what is 'given' for any actual entity is the outcome of thwarting, contrary decisions from the settled world.

Chaotic disorder means lack of dominant definition of compatible contrasts in the satisfactions attained, and consequent enfeeblement of intensity. It means the lapse towards slighter actuality. It is a natural figure of speech, but only a figure of speech, to conceive a slighter actuality as being an approach towards nonentity. But you cannot approach nothing; for there is nothing to approach. It is an approach towards the futility of being a faint compromise between contrary reasons. The dominance of societies, harmoniously requiring each other, is the essential condition for depth of satisfaction.

The *Timaeus* of Plato, and the *Scholium* of Newton—the latter already in large part quoted—are the two statements of cosmological theory which have had the chief influence on Western thought. To the modern reader, the *Timaeus,* considered as a statement of scientific details, is in comparison with the *Scholium* simply foolish. But what it lacks in superficial detail, it makes up for by its philosophic depth. If it be read as an allegory, it conveys profound truth; whereas the *Scholium* is an immensely able statement of details which, although abstract and inadequate as a philosophy, can within certain limits be thoroughly trusted for the deduction of truths at the same level of abstraction as itself. The penalty of its philosophical deficiency is that the *Scholium* conveys no hint of the limits of its own application. The practical effect is that the readers, and almost certainly Newton himself, so construe its meaning as to fall into what I have elsewhere * termed the 'fallacy of misplaced concreteness.' It is the office of metaphysics to determine the limits of the applicability of such abstract notions.

The *Scholium* betrays its abstractness by affording no hint of that aspect of self-production, of generation, of Φύσις, of *natura naturans,* which is so prominent in nature. For the *Scholium,* nature is merely, and completely, *there* externally designed and obedient. The full sweep of the modern doctrine of evolution would have confused the Newton of the *Scholium,* but would have enlightened the Plato of the *Timaeus.* So far as Newton is concerned, we have his own word for this statement. In a letter to Bentley, he writes: 'When I wrote my treatise about our system, I had an eye upon such principles as might work with considering men for the belief of a Deity; . . .' † The

* Cf. *Science and the Modern World,* Ch. III.

† This quotation is taken from Jebb's *Life of Bentley,* Ch. II. The *Life* is published in the English Men of Letters series.

concept in Newton's mind is that of a fully articulated system requiring a definite supernatural origin with that articulation. This is the form of the cosmological argument, now generally abandoned as invalid; because our notion of causation concerns the relations of states of things within the actual world, and can only be illegitimately extended to a transcendent derivation. The notion of God, which will be discussed later,* is that of an actual entity immanent in the actual world, but transcending any finite cosmic epoch—a being at once actual, eternal, immanent, and transcendent. The transcendence of God is not peculiar to him. Every actual entity, in virtue of its novelty, transcends its universe, God included.

In the *Scholium,* space and time, with all their current mathematical properties, are ready-made for the material masses; the material masses are ready-made for the 'forces' which constitute their action and reaction; and space, and time, and material masses, and forces, are alike ready-made for the initial motions which the Deity impresses throughout the universe. It is not possible to extract from the *Scholium*—construed with misplaced concreteness—either a theism, or an atheism, or an epistemology, which can survive a comparison with the facts. This is the inescapable conclusion to be inferred from Hume's *Dialogues Concerning Natural Religion.* Biology is also reduced to a mystery; and finally physics itself has now reached a stage of experimental knowledge inexplicable in terms of the categories of the *Scholium.*

In the *Timaeus,* there are many phrases and statements which find their final lucid expression in the *Scholium.* While noting this concurrence of the two great cosmological documents guiding Western thought, it cannot be too clearly understood that, within its limits of abstraction, what the *Scholium* says is true, and that it is expressed with the lucidity of genius. Thus any cosmological document which cannot be read as an interpretation of the *Scholium* is worthless. But there is another side to the *Timaeus* which finds no analogy in the *Scholium.* In general terms, this side of the *Timaeus* may be termed its metaphysical character, that is to say, its endeavour to connect the *behaviour* of things with the *formal nature* of things. The behaviour apart from the things is abstract, and so are the things apart from their behaviour. Newton—wisely, for his purposes—made this abstraction which the *Timaeus* endeavours to avoid.

* Cf. Part IV, *Process and Reality.*

In the first place, the *Timaeus* connects behaviour with the ultimate molecular characters of the actual entities. Plato conceives the notion of definite societies of actual molecular entities, each society with its defining characteristics. He does not conceive this assemblage of societies as *causa sui*. But he does conceive it as the work of subordinate deities, who are the animating principles of those departments of nature. In Greek thought, either poetic or philosophic, the separation between the Φύσις and such deities had not that absolute character which it has for us who have inherited the Semitic Jehovah.

Newton could have accepted a molecular theory as easily as Plato, but there is this difference between them: Newton would have been surprised at the modern quantum theory and at the dissolution of quanta into vibrations; Plato would have expected it. While we note the many things said by Plato in the *Timaeus* which are now foolishness, we must also give him credit for that aspect of his teaching in which he was two thousand years ahead of his time. Plato accounted for the sharp-cut differences between kinds of natural things, by assuming an approximation of the molecules of the fundamental kinds respectively to the mathematical forms of the regular solids. He also assumed that certain qualitative contrasts in occurrences, such as that between musical notes, depended on the participation of these occurrences in some of the simpler ratios between integral numbers. He thus obtained a reason why there should be an approximation to sharp-cut differences between kinds of molecules, and why there should be sharp-cut relations of harmony standing out amid dissonance. Thus 'contrast'—as the opposite of incompatibility—depends on a certain simplicity of circumstance; but the higher contrasts depend on the assemblage of a multiplicity of lower contrasts, this assemblage again exhibiting higher types of simplicity.

It is well to remember that the modern quantum theory, with its surprises in dealing with the atom, is only the latest instance of a well-marked character of nature, which in each particular instance is only explained by some *ad hoc* dogmatic assumption. The theory of biological evolution would not in itself lead us to expect the sharply distinguished genera and species which we find in nature. There might be an occasional bunching of individuals round certain typical forms; but there is no explanation of the almost complete absence of intermediate forms. Again Newton's *Scholium* gives no hint of the ninety-two possibilities for atoms, or of the limited number of

ways in which atoms can be combined so as to form molecules. Physicists are now explaining these chemical facts by means of conceptions which Plato would have welcomed.

There is another point in which the organic philosophy only repeats Plato. In the *Timaeus* the origin of the present cosmic epoch is traced back to an aboriginal disorder, chaotic according to our ideals. This is the evolutionary doctrine of the philosophy of organism. Plato's notion has puzzled critics who are obsessed with the Semitic * theory of a wholly transcendent God creating out of nothing an accidental universe. Newton held the Semitic theory. The *Scholium* made no provision for the evolution of matter—very naturally, since the topic lay outside its scope. The result has been that the non-evolution of matter has been a tacit presupposition throughout modern thought. Until the last few years the sole alternatives were: either the material universe, with its present type of order, is eternal; or else it came into being, and will pass out of being, according to the fiat of Jehovah. Thus, on all sides, Plato's allegory of the evolution of a new type of order based on new types of dominant societies became a daydream, puzzling to commentators.

Milton, curiously enough, in his *Paradise Lost* wavers between the *Timaeus* and the Semitic doctrine. This is only another instance of the intermixture of classical and Hebrew notions on which his charm of thought depends. In the description of Satan's journey across Chaos, Satan discovers

> The secrets of the hoary deep, a dark
> Illimitable ocean, without bound,
> Without dimension, where length, breadth and highth,
> And time and place are lost; where eldest night
> And Chaos, ancestors of Nature, hold
> Eternal anarchy amidst the noise
> Of endless wars, and by confusion stand.†

Milton is here performing for Plato the same poetic service that Lucretius performed for Democritus—with less justification, since Plato was quite capable of being his own poet. Also the fact of Satan's journey helped to evolve order; for he left a permanent track, useful for the devils and the damned.

* The book of Genesis is too primitive to bear upon this point.
† Cf. *Paradise Lost,* Bk. II.

The appeal to Plato in this section has been an appeal to the facts against the modes of expression prevalent in the last few centuries. These recent modes of expression are partly the outcome of a mixture of theology and philosophy, and are partly due to the Newtonian physics, no longer accepted as a fundamental statement. But language and thought have been framed according to that mould; and it is necessary to remind ourselves that this is not the way in which the world has been described by some of the greatest intellects. Both for Plato and for Aristotle the process of the actual world has been conceived as a real incoming of forms into real potentiality, issuing into that real togetherness which is an actual thing. Also, for the *Timaeus,* the creation of the world is the incoming of a type of order establishing a cosmic epoch. It is not the beginning of matter of fact, but the incoming of a certain type of social order.

SECTION IV

The remainder of this chapter will be devoted to a discussion—largely conjectural—of the hierarchy of societies composing our present epoch. In this way, the preceding discussion of 'order' may be elucidated. It is to be carefully noted that we are now deserting metaphysical generality. We shall be considering the more special possibilities of explanation consistent with our general cosmological doctrine, but not necessitated by it.

The physical world is bound together by a general type of relatedness which constitutes it into an extensive continuum. When we analyse the properties of this continuum we discover that they fall into two classes, of which one—the more special—presupposes the other—the more general.* The more general type of properties expresses the mere fact of 'extensive connection,' of 'whole and part,' of various types of 'geometrical elements' derivable by 'extensive abstraction'; but excluding the introduction of more special properties by which straight lines are definable † and measurability thereby introduced.

In these general properties of extensive connection, we discern the defining characteristic of a vast nexus extending far beyond our immediate cosmic epoch. It contains in itself other epochs, with more particular characteristics incompatible with each other. Then from

* Cf. Part IV, *Process and Reality,* for a detailed discussion.
† Cf. Part IV, Ch. III, IV, V, *Process and Reality.*

the standpoint of our present epoch, the fundamental society in so far as it transcends our own epoch seems a vast confusion mitigated by the few, faint elements of order contained in its own defining characteristic of 'extensive connection.' We cannot discriminate its other epochs of vigorous order, and we merely conceive it as harbouring the faint flush of the dawn of order in our own epoch. This ultimate, vast society constitutes the whole environment within which our epoch is set, so far as systematic characteristics are discernible by us in our present stage of development. In the future the growth of theory may endow our successors with keener powers of discernment.

Our logical analysis, in company with immediate intuition (*inspectio*), enables us to discern a more special society within the society of pure extension. This is the 'geometrical' society. In this society * those specialized relationships hold, in virtue of which straight lines are defined. Systematic geometry is illustrated in such a geometrical society; and metrical relationships can be defined in terms of the analogies of function within the scheme of any one systematic geometry. These 'analogies of function' are what is meant by the notion of 'congruence.' This notion is nonsense apart from a systematic geometry. The inclusion of *extensive quantity* among fundamental categoreal notions is a complete mistake. This notion is definable in terms of each systematic geometry finding its application in a geometrical society. It is to be noticed that a systematic geometry is determined by the definition of straight lines applicable to the society in question. Contrary to the general opinion, this definition is possible in independence of the notion of 'measurement.' It cannot however be proved that in the same geometrical society there may not be competing families of loci with equal claims to the status of being a complete family of straight lines.

Given a family of straight lines, expressing a system of relatedness in a 'geometric' society, the notion of 'congruence' and thence of 'measurement' is now determinable in a systematic way throughout the society. But again in this case there certainly are competing systems of measurement. Hence in connection with *each* family of straight lines—allowing there be more than one such family—there are alternative systems † of *metrical* geometry, no one system being

* Cf. Part IV, especially Ch. III, IV, V, *Process and Reality*.

† The existence of alternative systems was demonstrated by Cayley in his *Sixth Memoir on Quantities* in R. S., Transl., 1859.

more fundamental than the other. Our present cosmic epoch is formed by an 'electromagnetic' society, which is a more special society contained within the geometric society. In this society yet more special defining characteristics obtain. These characteristics presuppose those of the two wider societies within which the 'electromagnetic' society is contained. But in the 'electromagnetic' society the ambiguity as to the relative importance of competing families of straight lines (if there be such competing families), and the ambiguity as to the relative importance of competing definitions of congruence, are determined in favour of one family and one * congruence-definition. This determination is effected by an additional set of physical relationships throughout the society. But this set has lost its merely systematic character because it constitutes our neighbourhood. These relationships involve components expressive of certain individual diversities, and identities between the occasions which are the members of the nexus. But these diversities and identities are correlated according to a systematic law expressible in terms of the systematic measurements derived from the geometric nexus. We here arrive at the notion of physical quantities which vary from individual to individual; this is the notion of the systematisation of individual differences, the notion of 'Law.'

It is the ideal of mathematical physicists to formulate this systematic law in its complete generality for our epoch. It is sufficient for our purposes to indicate the presumed character of this law by naming the members of the society 'electromagnetic occasions.' Thus our present epoch is dominated by a society of electromagnetic occasions. In so far as this dominance approaches completeness, the systematic law which physics seeks is absolutely dominant. In so far as the dominance is incomplete, the obedience is a statistical fact with its corresponding lapses.

The electromagnetic society exhibits the physical electromagnetic field which is the topic of physical science. The members of this nexus are the electromagnetic occasions.

But in its turn, this electromagnetic society would provide no adequate order for the production of individual occasions realizing peculiar 'intensities' of experience unless it were pervaded by more

* The transformations into an indefinite variety of coordinates to which the 'tensor theory' refers, all presuppose one congruence definition. The invariance of the Einsteinian 'ds' expresses this fact.

special societies, vehicles of such order. The physical world exhibits a bewildering complexity of such societies, favouring each other, competing with each other.

The most general examples of such societies are the regular trains of waves, individual electrons, protons, individual molecules, societies of molecules such as inorganic bodies, living cells, and societies of cells such as vegetable and animal bodies.

SECTION V

It is obvious that the simple classification (cf. Part I, Ch. III, Sec. II) of societies into 'enduring objects,' 'corpuscular societies,' and 'non-corpuscular societies' requires amplification. The notion of a society which includes subordinate societies and nexūs with a definite pattern of structural inter-relations, must be introduced. Such societies will be termed 'structured.'

A structured society as a whole provides a favourable environment for the subordinate societies which it harbours within itself. Also the whole society must be set in a wider environment permissive of its continuance. Some of the component groups of occasions in a structured society can be termed 'subordinate societies.' But other such groups must be given the wider designation of 'subordinate nexūs.' The distinction arises because in some instances a group of occasions, such as, for example, a particular enduring entity, could have retained the dominant features of its defining characteristic in the general environment, apart from the structured society. It would have lost some features; in other words, the analogous sort of enduring entity in the general environment is, in its mode of definiteness, not quite identical with the enduring entity within the structured environment. But, abstracting such additional details from the generalised defining characteristic, the enduring object with that generalised characteristic may be conceived as independent of the structured society within which it finds it. For example, we speak of a molecule within a living cell, because its general molecular features are independent of the environment of the cell. Thus a molecule is a subordinate society in the structured society which we call the 'living cell.'

But there may be other nexūs included in a structured society which, excepting the general systematic characteristics of the external

environment, present no features capable of genetically sustaining themselves apart from the special environment provided by that structured society. It is misleading, therefore, to term such a nexus a 'society' when it is being considered in abstraction from the whole structured society. In such an abstraction it can be assigned no 'social' features. Recurring to the example of a living cell, it will be argued that the occasions composing the 'empty' space within the cell exhibit special features which analogous occasions outside the cell are devoid of. Thus the nexus, which is the empty space within a living cell, is called a 'subordinate nexus,' but not a 'subordinate society.'

Molecules are structured societies, and so in all probability are separate electrons and protons. Crystals are structured societies. But gases are not structured societies in any important sense of that term; although their individual molecules are structured societies.

It must be remembered that each individual occasion within a special form of society includes features which do not occur in analogous occasions in the external environment. The first stage of systematic investigation must always be the identification of analogies between occasions within the society and occasions without it. The second stage is constituted by the more subtle procedure of noting the differences between behaviour within and without the society, difference of behaviour exhibited by occasions which also have close analogies to each other. The history of science is marked by the vehement, dogmatic denial of such differences, until they are found out.

An obvious instance of such distinction of behaviour is afforded by the notion of the deformation of the shape of an electron according to variations in its physical situation.

A 'structured society' may be more or less 'complex' in respect to the multiplicity of its associated sub-societies and sub-nexūs and to the intricacy of their structural pattern.

A structured society which is highly complex can be correspondingly favourable to intensity of satisfaction for certain sets of its component members. This intensity arises by reason of the ordered complexity of the contrasts which the society stages for these components.

The structural relations gather intensity from this intensity in the individual experiences. Thus the growth of a complex structured so-

ciety exemplifies the general purpose pervading nature. The mere complexity of givenness which procures incompatibilities has been superseded by the complexity of order which procures contrasts.

SECTION VI

The doctrine that every society requires a wider social environment leads to the distinction that a society may be more or less 'stabilized' in reference to certain sorts of changes in that environment. A society is 'stabilized' in reference to a species of change when it can persist through an environment whose relevant parts exhibit that sort of change. If the society would cease to persist through an environment with that sort of heterogeneity, then the society is in that respect 'unstable.' A complex society which is stable provided that the environment exhibits certain features, is said to be 'specialized' in respect to those features. The notion of 'specialisation' seems to include both that of 'complexity' and that of strictly conditioned 'stability.'

An unspecialised society can survive through important changes in its environment. This means that it can take on different functions in respect to its relationship to a changing environment. In general the defining characteristic of such a society will not include any particular determination of structural pattern. By reason of this flexibility of structural pattern, the society can adopt that special pattern adapted to the circumstances of the moment. Thus an unspecialized society is apt to be deficient in structural pattern, when viewed as a whole.

Thus in general an unspecialised society does not secure conditions favourable for intensity of satisfaction among its members. Whereas a structured society with a high grade of complexity will in general be deficient in survival value. In other words, such societies will in general be 'specialised' in the sense of requiring a very special sort of environment.

Thus the problem for Nature is the production of societies which are 'structured' with a high 'complexity,' and which are at the same time 'unspecialised.' In this way, intensity is mated with survival.

SECTION VII

There are two ways in which structured societies have solved this problem. Both ways depend on that enhancement of the mental pole, which is a factor in intensity of experience. One way is by eliciting

a massive average objectification of a nexus, while eliminating the detailed diversities of the various members of the nexus in question. This method, in fact, employs the device of blocking out unwelcome detail. It depends on the fundamental truth that objectification is abstraction. It utilizes the abstraction inherent in objectification so as to dismiss the thwarting elements of a nexus into negative prehensions. At the same time the complex intensity in the structured society is supported by the massive objectifications of the many environmental nexūs, each in its unity as *one* nexus, and not in its multiplicity as *many* actual occasions.

This mode of solution requires the intervention of mentality operating in accordance with the Category of Transmutation (i.e., Categoreal Obligation VI). It ignores diversity of detail by overwhelming the nexus by means of some congenial uniformity which pervades it. The environment may then change indefinitely so far as concerns the ignored details—so long as they can be ignored.

The close association of all physical bodies, organic and inorganic alike, with 'presented loci' definable * by straight lines, suggests that this development of mentality is characteristic of the actual occasions which make up the structured societies which we know as 'material bodies.' This close association is evidenced by the importance of 'acceleration' in the science of Dynamics. For 'acceleration' is nothing else than a mode of estimating the shift from one family of 'presented loci' to another such family. †

Such mentality represents the first grade of ascent beyond the mere reproductive stage which employs nothing more than the Category of Conceptual Reproduction (i.e., Categoreal Obligation IV). There is some initiative of conceptual integration, but no originality in conceptual prehension. This initiative belongs to the Category of Transmutation, and the excluded originality belongs to the Category of Reversion.

These material bodies belong to the lowest grade of structured societies which are obvious to our gross apprehensions. They comprise societies of various types of complexity—crystals, rocks, planets, and suns. Such bodies are easily the most long-lived of the structured societies known to us, capable of being traced through their individual life-histories.

The second way of solving the problem is by an initiative in con-

* Cf. Ch. IV of this 'part' and also Part IV, *Process and Reality*.
† Cf. Part IV, *Process and Reality*.

ceptual prehensions, i.e., in appetition. The purpose of this initiative is to receive the novel elements of the environment into explicit feelings with such subjective forms as conciliate them with the complex experiences proper to members of the structured society. Thus in each concrescent occasion its subjective aim originates novelty to match the novelty of the environment.

In the case of the higher organisms, this conceptual initiative amounts to *thinking* about the diverse experiences; in the case of lower organisms this conceptual initiative merely amounts to thoughtless adjustment of aesthetic emphasis in obedience to an ideal of harmony. In either case the creative determination which transcends the occasion in question has been deflected by an impulse original to that occasion. This deflection in general originates a self-preservative reaction throughout the whole society. It may be unfortunate or inadequate; and in the case of persistent failure we are in the province of pathology.

This second mode of solution also presupposes the former mode. Thus the categories of Conceptual Reversion and of Transmutation are both called into play.

Structured societies in which the second mode of solution has importance are termed 'living.' It is obvious that a structured society may have more or less 'life,' and that there is no absolute gap between 'living' and 'non-living' societies. For certain purposes, whatever 'life' there is in a society may be important; and for other purposes, unimportant.

A structured society in which the second mode is unimportant, and the first mode is important will be termed 'inorganic.'

In accordance with this doctrine of 'life,' the primary meaning of 'life' is the origination of conceptual novelty—novelty of appetition. Such origination can only occur in accordance with the Category of Reversion. Thus a society is only to be termed 'living' in a derivative sense. A 'living society' is one which includes some 'living occasions.' Thus a society may be more or less 'living,' according to the prevalence in it of living occasions. Also an occasion may be more or less living according to the relative importance of the novel factors in its final satisfaction.

Thus the two ways in which dominant members of structured societies secure stability amid environmental novelties are (i) elimination of diversities of detail, and (ii) origination of novelties of con-

ceptual reaction. As the result, there is withdrawal or addition of those details of emphasis whereby the subjective aim directs the integration of prehensions in the concrescent phases of dominant members.

SECTION VIII

There is yet another factor in 'living' societies which requires more detached analysis. A structured society consists in the patterned intertwining of various nexūs with markedly diverse defining characteristics. Some of these nexūs are of lower types than others, and some will be of markedly higher types. There will be the 'subservient' nexūs and the 'regnant' nexūs within the same structured society. This structured society will provide the immediate environment which sustains each of its sub-societies, subservient and regnant alike. In a living society only some of its nexūs will be such that the mental poles of all their members have any *original* reactions. These will be its 'entirely living' nexūs, and in practice a society is only called 'living' when such nexūs are regnant. Thus a living society involves nexūs which are 'inorganic,' and nexūs which are inorganic do not need the protection of the whole 'living' society for their survival in a changing eternal environment. Such nexūs are societies. But 'entirely living' nexūs do require such protection, if they are to survive. According to this conjectural theory, an 'entirely living' nexus is not a 'society.' This is the theory of the animal body, including a unicellular body as a particular instance. A complex inorganic system of interaction is built up for the protection of the 'entirely living' nexūs, and the originative actions of the living elements are protective of the whole system. On the other hand, the reaction of the whole system provides the intimate environment required by the 'entirely living' nexūs. We do not know of any living society devoid of its subservient apparatus of inorganic societies.

'Physical Physiology' deals with the subservient inorganic apparatus; and 'Psychological Physiology' seeks to deal with 'entirely living' nexūs, partly in abstraction from the inorganic apparatus, and partly in respect to their response to the inorganic apparatus, and partly in regard to their response to each other. Physical Physiology has, in the last century, established itself as a unified science; Psychological Physiology is still in the process of incubation.

It must be remembered that an integral living society, as we know

it, not only includes the subservient inorganic apparatus, but also includes many living nexūs at least one for each 'cell.'

SECTION IX

It will throw light upon the cosmology of the philosophy of organism to conjecture some fundamental principles of Psychological Physiology as suggested by that cosmology and by the preceding conjectures concerning the 'societies' of our epoch. These principles are not necessitated by this cosmology; but they seem to be the simplest principles which are both consonant with that cosmology, and also fit the facts.

In the first instance, consider a single living cell. Such a cell includes subservient inorganic societies, such as molecules and electrons. Thus, the cell is an 'animal body'; and we must presuppose the 'physical physiology' proper to this instance. But what of the individual living occasions?

The first question to be asked is as to whether the living occasions, in abstraction from the inorganic occasions of the animal body, form a corpuscular sub-society, so that each living occasion is a member of an enduring entity with its personal order. In particular we may ask whether this corpuscular society reduces to the extreme instance of such a society, namely, to one enduring entity with its one personal order?

The evidence before us is of course extremely slight; but so far as it goes, it suggests a negative answer to both these questions. A cell gives no evidence whatever of a single unified mentality, guided in each of its occasions by inheritance from its own past. The problem to be solved is that of a certain originality in the response of a cell to external stimulus. The theory of an enduring entity with its inherited mentality gives us a reason why this mentality should be swayed by its own past. We ask for something original at the moment, and we are provided with a reason for limiting originality. Life is a bid for freedom: an enduring entity binds any one of its occasions to the line of its ancestry. The doctrine of the enduring soul with its permanent characteristics is exactly the irrelevant answer to the problem which life presents. That problem is, How can there be originality? And the answer explains how the soul need be no more original than a stone.

The theory of a corpuscular society, made up of many enduring

entities, fits the evidence no better. The same objections apply. The root fact is that 'endurance' is a device whereby an occasion is peculiarly bound by a single line of physical ancestry, while 'life' means novelty, introduced in accordance with the Category of Conceptual Reversion. There are the same objections to *many* traditions as there are to *one* tradition. What has to be explained is originality of response to stimulus. This amounts to the doctrine that an organism is 'alive' when in some measure its reactions are inexplicable by *any* tradition of pure physical inheritance.

Explanation by 'tradition' is merely another phraseology for explanation by 'efficient cause.' We require explanation by 'final cause.' Thus a single occasion is alive when the subjective aim which determines its process of concrescence has introduced a novelty of definiteness not to be found in the inherited data of its primary phase. The novelty is introduced conceptually and disturbs the inherited 'responsive' adjustment of subjective forms. It alters the 'values,' in the artist's sense of that term.

It follows from these considerations that in abstraction from its animal body an 'entirely living' nexus is not properly a society at all, since 'life' cannot be a defining characteristic. It is the name for originality, and not for tradition. The mere response to stimulus is characteristic of all societies whether inorganic or alive. Action and reaction are bound together. The characteristic of life is reaction adapted to the capture of intensity, under a large variety of circumstances. But the reaction is dictated by the present and not by the past. It is the clutch at vivid immediacy.

SECTION X

Another characteristic of a living society is that it requires food. In a museum the crystals are kept under glass cases; in zoological gardens the animals are fed. Having regard to the universality of reactions with environment, the distinction is not quite absolute. It cannot, however, be ignored. The crystals are not agencies requiring the destruction of elaborate societies derived from the environment; a living society is such an agency. The societies which it destroys are its food. This food is destroyed by dissolving it into somewhat simpler social elements. It has been robbed of something. Thus, all societies require interplay with their environments; and in the case of living societies this interplay takes the form of robbery. The living

society may, or may not, be a higher type of organism than the food which it disintegrates. But whether or no it be for the general good, life is robbery. It is at this point that with life morals become acute. The robber requires justification.

The primordial appetitions which jointly constitute God's purpose are seeking intensity, and not preservation. Because they are primordial, there is nothing to preserve. He, in his primordial nature, is unmoved by love for this particular, or that particular; for in this foundational process of creativity, there are no preconstituted particulars. In the foundations of his being, God is indifferent alike to preservation and to novelty. He cares not whether an immediate occasion be old or new, so far as concerns derivation from its ancestry. His aim * for it is depth of satisfaction as an intermediate step towards the fulfilment of his own being. His tenderness is directed towards each actual occasion, as it arises.

Thus God's purpose in the creative advance is the evocation of intensities. The evocation of societies is purely subsidiary to this absolute end. The characteristic of a living society is that a complex structure of inorganic societies is woven together for the production of a non-social nexus characterized by the intense physical experiences of its members. But such an experience is derivate from the complex order of the material animal body, and not from the simple 'personal order' of past occasions with analogous experience. There is intense experience without the shackle of reiteration from the past. This is the condition for spontaneity of conceptual reaction. The conclusion to be drawn from this argument is that life is a characteristic of 'empty space' and not of space 'occupied' by any corpuscular society. In a nexus of living occasions, there is a certain social deficiency. Life lurks in the interstices of each living cell, and in the interstices of the brain. In the history of a living society, its more vivid manifestations wander to whatever quarter is receiving from the animal body an enormous variety of physical experience. This experience, if treated inorganically, must be reduced to compatibility by the normal adjustments of mere responsive reception. This means the dismissal of incompatible elements into negative prehensions.

The complexity of the animal body is so ordered that in the critical portions of its interstices the varied datum of physical experience is complex, and on the edge of a compatibility beyond that to be

* Cf. Part V, *Process and Reality*.

achieved by mere inorganic treatment. A novel conceptual prehension disturbs the subjective forms of the initial responsive phase. Some negative prehensions are thus avoided, and higher contrasts are introduced into experience.

So far as the functioning of the animal body is concerned, the total result is that the transmission of physical influence, through the empty space within it, has not been entirely in conformity with the physical laws holding for inorganic societies. The molecules within an animal body exhibit certain peculiarities of behaviour not to be detected outside an animal body. In fact, living societies illustrate the doctrine that the laws of nature develop together with societies which constitute an epoch. There are statistical expressions of the prevalent types of interaction. In a living cell, the statistical balance has been disturbed.

The connection of 'food' with 'life' is now evident. The highly complex inorganic societies required for the structure of a cell, or other living body, lose their stability amid the diversity of the environment. But, in the physical field of empty space produced by the originality of living occasions, chemical dissociations and associations take place which would not otherwise occur. The structure is breaking down and being repaired. The food is that supply of highly complex societies from the outside which, under the influence of life, will enter into the necessary associations to repair the waste. Thus life acts as though it were a catalytic agent.

The short summary of this account of a living cell is as follows: (i) an extremely complex and delicately poised chemical structure; (ii) for the occasions in the interstitial 'empty' space a complex objective datum derived from this complex structure; (iii) under normal 'responsive' treatment, devoid of originality, the complex detail reduced to physical simplicity by negative prehensions; (iv) this detail preserved for positive feeling by the emotional and purposive readjustments produced by originality of conceptual feeling (appetition); (v) the physical distortion of the field, leading to instability of the structure; (vi) the structure accepting repair by food from the environment.

SECTION XI

The complexity of nature is inexhaustible. So far we have argued that the nature of life is not to be sought by its identification with some society of occasions, which are living in virtue of the defining

characteristic of that society. An 'entirely living' nexus is, in respect to its life, not social. Each member of the nexus derives the necessities of its being from its prehensions of its complex social environment; by itself the nexus lacks the genetic power which belongs to 'societies.' But a living nexus, though non-social in virtue of its 'life,' may support a thread of personal order along some historical route of its members. Such an enduring entity is a 'living person.' It is not of the essence of life to be a living person. Indeed a living person requires that its immediate environment be a living, non-social nexus.

The defining characteristic of a living person is some definite type of hybrid prehensions transmitted from occasion to occasion of its existence. The term 'hybrid' is defined more particularly in Part III.* It is sufficient to state here that a 'hybrid' prehension is the prehension by one subject of a conceptual prehension, or of an 'impure' prehension, belonging to the mentality of another subject. By this transmission the mental originality of the living occasions receives a character and a depth. In this way originality is both 'canalized'—to use Bergson's word—and intensified. Its range is widened within limits. Apart from canalization, depth of originality would spell disaster for the animal body. With it, personal mentality can be evolved, so as to combine its individual originality with the safety of the material organism on which it depends. Thus life turns back into society: it binds originality within bounds, and gains the massiveness due to reiterated character.

In the case of single cells, of vegetation, and of the lower forms of animal life, we have no ground for conjecturing living personality. But in the case of the higher animals there is central direction, which suggests that in their case each animal body harbours a living person, or living persons. Our own self-consciousness is direct awareness of ourselves as such persons.† There are limits to such unified control, which indicate dissociation of personality, multiple personalities in successive alternations, and even multiple personalities in joint possession. This last case belongs to the pathology of religion, and in primitive times has been interpreted as demoniac possession.

* *Process and Reality.*

† This account of a living personality requires completion by reference to its objectification in the consequent nature of God. Cf. Part V, Ch. II, *Process and Reality.*

Thus, though life in its essence is the gain of intensity through freedom, yet it can also submit to canalization and so gain the massiveness of order. But it is not necessary merely to presuppose the drastic case of personal order. We may conjecture, though without much evidence, that even in the lowest form of life the entirely living nexus is canalized into some faint form of mutual conformity. Such conformity amounts to social order depending on hybrid prehensions of originalities in the mental poles of the antecedent members of the nexus. The survival power, arising from adaptation and regeneration, is thus explained. Thus life is a passage from physical order to pure mental originality, and from pure mental originality to canalized mental originality. It must also be noted that the pure mental originality works by the canalization of relevance arising from the primordial nature of God. Thus an originality in the temporal world is conditioned, though not determined, by an initial subjective aim supplied by the ground of all order and of all originality.

Finally, we have to consider the type of structural society which gives rise to the traditional body-mind problem. For example, human mentality is partly the outcome of the human body, partly the single directive agency of the body, partly a system of cogitations which have a certain irrelevance to the physical relationships of the body. The Cartesian philosophy is based upon the seeming fact—the plain fact—of one body and one mind, which are two substances in casual association. For the philosophy of organism the problem is transformed.

Each actuality is essentially bipolar, physical and mental, and the physical inheritance is essentially accompanied by a conceptual reaction partly conformed to, and partly introductory of, a relevant novel contrast, but always introducing emphasis, valuation, and purpose. The integration of the physical and mental side into a unity of experience is a self-formation which is a process of concrescence, and which by the principle of objective immortality characterizes the creativity which transcends it. So though mentality is non-spatial, mentality is always a reaction from, and integration with, physical experience which is spatial. It is obvious that we must not demand another mentality presiding over these other actualities (a kind of Uncle Sam, over and above all the U. S. citizens). All the life in the body is the life of the individual cells. There are thus millions upon

millions of centres of life in each animal body. So what needs to be explained is not dissociation of personality but unifying control, by reason of which we not only have unified behaviour, which can be observed by others, but also consciousness of a unified experience.

A good many actions do not seem to be due to the unifying control, e.g., with proper stimulants a heart can be made to go on beating after it has been taken out of the body. There are centres of reaction and control which cannot be identified with the centre of experience. This is still more so with insects. For example, worms and jellyfish seem to be merely harmonized cells, very little centralized; when cut in two, their parts go on performing their functions independently. Through a series of animals we can trace a progressive rise into a centrality of control. Insects have some central control; even in man, many of the body's actions are done with some independence, but with an organ of central control of very high-grade character in the brain.

The state of things, according to the philosophy of organism, is very different from the Scholastic view of St. Thomas Aquinas, of the mind as informing the body. The living body is a coördination of high-grade actual occasions; but in a living body of a low type the occasions are much nearer to a democracy. In a living body of a high type there are grades of occasions so coördinated by their paths of inheritance through the body, that a peculiar richness of inheritance is enjoyed by various occasions in some parts of the body. Finally, the brain is coördinated so that a peculiar richness of inheritance is enjoyed now by this and now by that part; and thus there is produced the presiding personality at that moment in the body. Owing to the delicate organization of the body, there is a returned influence, an inheritance of character derived from the presiding occasion and modifying the subsequent occasions through the rest of the body.

We must remember the extreme generality of the notion of an enduring object—a genetic character inherited through a historic route of actual occasions. Some kinds of enduring objects form material bodies, others do not. But just as the difference between living and non-living occasions is not sharp, but more or less, so the distinction between an enduring object which is an atomic material body and one which is not, is again more or less. Thus the

question as to whether to call an enduring object a transition of matter or of character is very much a verbal question as to where you draw the line between the various properties (cf. the way in which the distinction between matter and radiant energy has now vanished).

Thus in an animal body the presiding occasion, if there be one, is the final node, or intersection, of a complex structure of many enduring objects. Such a structure pervades the human body. The harmonized relations of the parts of the body constitute this wealth of inheritance into a harmony of contrasts, issuing into intensity of experience. The inhibitions of opposites have been adjusted into the contrasts of opposites. The human mind is thus conscious of its body inheritance. There is also an enduring object formed by the inheritance from presiding occasion to presiding occasion. This endurance of the mind is only one more example of the general principle on which the body is constructed. This route of presiding occasions probably wanders from part to part of the brain, dissociated from the physical material atoms. But central personal dominance is only partial, and in pathological cases is apt to vanish.

CHAPTER IV *ORGANISMS AND ENVIRONMENT*

SECTION I

So far the discussion has chiefly concentrated upon the discrimination of the modes of functioning which in germ, or in mere capacity, are represented in the constitution of each actual entity. The presumption that there is only one genus of actual entities constitutes an ideal of cosmological theory to which the philosophy of organism endeavours to conform. The description of the generic character of an actual entity should include God, as well as the lowliest actual occasion, though there is a specific difference between the nature of God and that of any occasion.

Also the differences between actual occasions, arising from the characters of their data, and from the narrowness and widths of their feelings, and from the comparative importance of various stages,

enable a classification to be made whereby these occasions are gathered into various types. From the metaphysical standpoint these types are not to be sharply discriminated; as a matter of empirical observation, the occasions do seem to fall into fairly distinct classes.

The character of an actual entity is finally governed by its datum; whatever be the freedom of feeling arising in the concrescence, there can be no transgression of the limitations of capacity inherent in the datum. The datum both limits and supplies. It follows from this doctrine that the character of an organism depends on that of its environment. But the character of an environment is the sum of the characters of the various societies of actual entities which jointly constitute that environment; although it is pure assumption that every environment is completely overrun by societies of entities. Spread through the environment there may be many entities which cannot be assigned to any society of entities. The societies in an environment will constitute its orderly element, and the non-social actual entities will constitute its element of chaos. There is no reason, so far as our knowledge is concerned, to conceive the actual world as purely orderly, or as purely chaotic.

Apart from the reiteration gained from its societies, an environment does not provide the massiveness of emphasis capable of dismissing its contrary elements into negative prehensions. Any ideal of depth of satisfaction, arising from the combination of narrowness and width, can only be achieved through adequate order. In proportion to the chaos there is triviality. There are different types of order; and it is not true that in proportion to the orderliness there is depth. There are various types of order, and some of them provide more trivial satisfaction than do others. Thus, if there is to be progress beyond limited ideals, the course of history by way of escape must venture along the borders of chaos in its substitution of higher for lower types of order.

The immanence of God gives reason for the belief that pure chaos is intrinsically impossible. At the other end of the scale, the immensity of the world negatives the belief that any state of order can be so established that beyond it there can be no progress. This belief in a final order, popular in religious and philosophic thought, seems to be due to the prevalent fallacy that all types of seriality necessarily involve terminal instances. It follows that Tennyson's phrase,

> . . . that far-off divine event
> To which the whole creation moves,

presents a fallacious conception of the universe.

An actual entity must be classified in respect to its 'satisfaction,' and this arises out of its datum by the operations constituting its 'process.' Satisfactions can be classified by reference to 'triviality,' 'vagueness,' 'narrowness,' 'width.' Triviality and vagueness are characteristics in the satisfaction which have their origins respectively in opposed characteristics in the datum. Triviality arises from lack of coördination in the factors of the datum, so that no feeling arising from one factor is reinforced by any feeling arising from another factor. In other words, the specific constitution of the actual entity in question is not such as to elicit depth of feeling from contrasts thus presented. Incompatibility has predominated over contrast. Then the process can involve no coördinating intensification either from a reinforced narrowness, or from enhancement of relevance due to the higher contrasts derived from harmonized width. Triviality is due to the wrong sort of width; that is to say, it is due to width without any reinforced narrowness in its higher categories. Harmony is this combination of width and narrowness. Some narrow concentration on a limited set of effects is essential for depth; but the difference arises in the levels of the categories of contrast involved. A high category involves unplumbed potentiality for the realization of depth in its lower components. Thus 'triviality' arises from excess of incompatible differentiation.

On the other hand, 'vagueness' is due to excess of identification. In the datum the objectifications of various actual entities are replicas with faint coördinations of perspective contrast. Under these conditions the contrasts between the various objectifications are faint, and there is deficiency in supplementary feeling discriminating the objects from each other. There can thus be intensive narrowness in the prehension of the whole nexus, by reason of the common character; combined with vagueness, which is the irrelevance of the differences between the definite actual entities of the nexus. The objectified entities reinforce each other by their likeness. But there is lack of differentiation among the component objectifications owing to the deficiency in relevant contrasts.

In this way a group of actual entities contributes to the satisfaction

as one extensive whole. It is divisible, but the actual divisions, and their sporadic differences of character, have sunk into comparative irrelevance beside the one character belonging to the whole and any of its parts.

By reason of vagueness, many count as one, and are subject to indefinite possibilities of division into such multifold unities. When there is such vague prehension, the differences between the actual entities so prehended are faint chaotic factors in the environment, and have thereby been relegated to irrelevance. Thus vagueness is an essential condition for the narrowness which is one condition for depth of relevance. It enables a background to contribute its revelant quota, and it enables a social group in the foreground to gain concentrated relevance for its community of character. The right chaos, and the right vagueness, are jointly required for any effective harmony. They produce the massive simplicity which has been expressed by the term 'narrowness.' Thus chaos is not to be identified with evil; for harmony requires the due coordination of chaos, vagueness, narrowness, and width.

According to this account, the background in which the environment is set must be discriminated into two layers. There is first the relevant background, providing a massive systematic uniformity. This background is the presupposed world to which all ordinary propositions refer. Secondly, there is the more remote chaotic background which has merely an irrelevant triviality, so far as concerns direct objectification in the actual entity in question. This background represents those entities in the actual world with such perspective remoteness that there is even a chaos of diverse cosmic epochs. In the background there is triviality, vagueness, and massive uniformity; in the foreground discrimination and contrasts, but always negative prehensions of irrelevant diversities.

SECTION II

Intensity is the reward of narrowness. The domination of the environment by a few social groups is the factor producing both the vagueness of discrimination between actual entities and the intensification of relevance of common characteristics. These are the two requisites for narrowness. The lower organisms have low-grade types of narrowness; the higher organisms have intensified contrasts in the higher categories. In describing the capacities, realized or un-

realized, of an actual occasion, we have, with Locke, tacitly taken human experience as an example upon which to found the generalized description required for metaphysics. But when we turn to the lower organisms we have first to determine which among such capacities fade from realization into irrelevance, that is to say, by comparison with human experience which is our standard.

In any metaphysical scheme founded upon the Kantian or Hegelian traditions, experience is the product of operations which lie among the higher of the human modes of functioning. For such schemes, ordered experience is the result of schematization of modes of *thought,* concerning causation, substance, quality, quantity.

The process by which experiential unity is attained, is thereby conceived in the guise of modes of thought. The exception is to be found in Kant's preliminary sections on 'Transcendental Aesthetic,' by which he provides space and time. But Kant, following Hume, assumes the radical disconnection of impressions *qua data;* and therefore conceives his transcendental aesthetic to be the mere description of a subjective process appropriating the data by orderliness of feeling.

The philosophy of organism aspires to construct a critique of pure feeling, in the philosophical position in which Kant put his *Critique of Pure Reason.* This should also supersede the remaining *Critiques* required in the Kantian philosophy. Thus in the organic philosophy Kant's 'Transcendental Aesthetic' becomes a distorted fragment of what should have been his main topic. The datum includes its own interconnections, and the first stage of the process of feeling is the reception into the responsive conformity of feeling whereby the datum, which is mere potentiality, becomes the individualized basis for a complex unity of realization.

This conception, as found in the philosophy of organism, is practically identical with Locke's ways of thought in the latter half of his *Essay.* He speaks of the ideas in the perceived objects, and tacitly presupposes their identification with corresponding ideas in the perceiving mind. The ideas in the objects have been appropriated by the subjective functioning of the perceiving mind. This mode of phraseology can be construed as a casual carelessness of speech on the part of Locke, or a philosophic inconsistency. But apart from this inconsistency Locke's philosophy falls to pieces; as in fact was its fate in the hands of Hume.

There is, however, a fundamental misconception to be found in Locke, and in prevalent doctrines of perception. It concerns the answer to the question as to the description of the primitive types of experience. Locke assumes that the utmost primitiveness is to be found in sense-perception. The seventeenth-century physics, with the complexities of primary and secondary qualities, should have warned philosophers that sense-perception was involved in complex modes of functioning. Primitive feeling is to be found at a lower level. The mistake was natural for mediaeval and Greek philosophers: for they had not modern physics before them as a plain warning. In sense-perception we have passed the Rubicon, dividing direct perception from the higher forms of mentality, which play with error and thus found intellectual empires.

The more primitive types of experience are concerned with sense-reception, and not with sense-perception. This statement will require some prolonged explanation. But the course of thought can be indicated by adopting Bergson's admirable phraseology, sense-reception is 'unspatialized,' and sense-perception is 'spatialized.' In sense-reception the sensa are the definiteness of emotion: they are emotional forms transmitted from occasion to occasion. Finally in some occasion of adequate complexity, the category of transmutation endows them with the new function of characterizing nexūs.

SECTION III

In the first place, those eternal objects which will be classified under the name 'sensa' constitute the lowest category of eternal objects. Such eternal objects do not express a manner of relatedness between other eternal objects. They are not contrasts, or patterns. Sensa are necessary as components in any actual entity, relevant in the realization of the higher grades. But a sensum does not, for its own realization, require any eternal object of a lower grade, though it does involve the potentiality of pattern and does gain access of intensity from some realization of status in some realized pattern. Thus a sensum requires, as a rescue from its shallowness of zero width, some selective relevance of wider complex eternal objects which include it as a component; but it does not involve the relevance of any eternal objects which it presupposes. Thus, in one sense, a sensum is simple; for its realization does not involve the concurrent realization of certain definite eternal objects, which are

its definite simple components. But, in another sense, each sensum is complex; for it cannot be dissociated from its potentiality for ingression into *any* actual entity, and for its potentiality of contrasts and of patterned relationships with other eternal objects. Thus each sensum shares the characteristic common to all eternal objects, that it introduces the notion of the logical variable, in both forms, the unselective 'any' and the selective 'some.'

It is possible that this definition of 'sensa' excludes some cases of contrast which are ordinarily termed 'sensa' and that it includes some emotional qualities which are ordinarily excluded. Its convenience consists in the fact that it is founded on a metaphysical principle, and not on an empirical investigation of the physiology of the human body.

Narrowness in the lowest category achieves such intensity as belongs to such experience, but fails by reason of deficiency of width. Contrast elicits depth, and only shallow experience is possible when there is a lack of patterned contrast. Hume notices the comparative failure of the higher faculty of imagination in respect to mere sensa. He exaggerates this comparative failure into a dogma of absolute inhibition to imagine a novel sensum; whereas the evidence which he himself adduces, of the imagination of a new shade of colour to fill a gap in a graduated scale of shades, shows that a contrast between given shades can be imaginatively extended so as to generate the imagination of the missing shade. But Hume's example also shows that imagination finds its easiest freedom among the higher categories of eternal objects.

A pattern is in a sense simple: a pattern is the 'manner' of a complex contrast abstracted from the specific eternal objects which constitute the 'matter' of the contrast. But the pattern refers unselectively to any eternal objects with the potentiality of being elements in the 'matter' of some contrast in that 'manner.'

A pattern and a sensum are thus both simple in the sense that neither involves other specified eternal objects in its own realization. The *manner* of a pattern is the individual essence of the pattern. But no individual essence is realizable apart from some of its potentialities of relationship, that is, apart from its relational essence. But a pattern lacks simplicity in another sense, in which a sensum retains simplicity. The realization of a pattern necessarily involves the concurrent realization of a group of eternal objects capable of contrast

in that pattern. The realization of the pattern is through the realization of this contrast. The realization might have occurred by means of another contrast in the same pattern; but some complex contrast in that pattern is required. But the realization of a sensum in its ideal shallowness of intensity, with zero width, does not require any other eternal object, other than its intrinsic apparatus of individual and relational essence; it can remain just itself, with its unrealized potentialities for patterned contrasts. An actual entity with this absolute narrowness has an ideal faintness of satisfaction, differing from the ideal zero of chaos, but equally impossible. For realization means ingression in an actual entity, and this involves the synthesis of all ingredients with data derived from a complex universe. Realization is ideally distinguishable from the ingression of contrasts, but not in fact.

The simplest grade of actual occasions must be conceived as experiencing a few sensa, with the minimum of patterned contrast. The sensa are then experienced emotionally, and constitute the specific feelings whose intensities sum up into the unity of satisfaction. In such occasions the process is deficient in its highest phases; the process is the slave to the datum. There is the individualizing phase of conformal feeling, but the originative phases of supplementary and conceptual feelings, are negligible.

SECTION IV

According to this account, the experience of the simplest grade of actual entity is to be conceived as the unoriginative response to the datum with its simple content of sensa. The datum is simple, because it presents the objectified experiences of the past under the guise of simplicity. Occasions A, B, and C enter into the experience of occasion M as themselves experiencing sensa s_1 and s_2 unified by some faint contrast between s_1 and s_2. Occasion M responsively feels sensa s_1 and s_2 as its own sensations. There is thus a transmission of sensation emotion from A, B, and C to M. If M had the wit of self-analysis, M would know that it felt its own sensa, by reason of a transfer from A, B, and C to itself. Thus the (unconscious) direct perception of A, B, and C is merely the causal efficacy of A, B, and C as elements in the constitution of M. Such direct perception will suffer from vagueness; for if A, B, and C tell the same tale with minor variation of intensity, the discrimination of A, and B, and C

from each other will be irrelevant. There may thus remain a sense of the causal efficacy of actual presences, whose exact relationships in the external world are shrouded. Thus the experience of *M* is to be conceived as a quantitative emotion arising from the contribution of sensa from *A, B, C* and proportionately conformed to by *M*.

Generalizing from the language of physics, the experience of *M* is an intensity arising out of specific sensa, directed from *A, B, C*. There is in fact a directed influx from *A, B, C* of quantitative feeling, arising from specific forms of feeling. The experience has a vector character, a common measure of intensity, and specific forms of feelings conveying that intensity. If we substitute the term 'energy' for the concept of a quantitative emotional intensity, and the term 'form of energy' for the concept of 'specific form of feeling,' and remember that in physics 'vector' means definite transmission from elsewhere, we see that this metaphysical description of the simplest elements in the constitution of actual entities agrees absolutely with the general principles according to which the notions of modern physics are framed. The 'datum' in metaphysics is the basis of the vector-theory in physics; the quantitative satisfaction in metaphysics is the basis of the scalar localization of energy in physics; the 'sensa' in metaphysics are the basis of the diversity of specific forms under which energy clothes itself. Scientific descriptions are, of course, entwined with the specific details of geometry and physical laws, which arise from the special order of the cosmic epoch in which we find ourselves. But the general principles of physics are exactly what we should expect as a specific exemplification of the metaphysics required by the philosophy of organism. It has been a defect in the modern philosophies that they throw no light whatever on any scientific principles. Science should investigate particular species, and metaphysics should investigate the generic notions under which those specific principles should fall. Yet, modern realisms have had nothing to say about scientific principles; and modern idealisms have merely contributed the unhelpful suggestion that the phenomenal world is one of the inferior avocations of the Absolute.

The direct perception whereby the datum in the immediate subject is inherited from the past can thus, under an abstraction, be conceived as the transference of throbs of emotional energy, clothed in the specific forms provided by sensa. Since the vagueness in the experiment subject will veil the separate objectifications wherein there

are individual contributions to the total satisfaction, the emotional energy in the final satisfaction wears the aspect of a total intensity capable of all gradations of ideal variation. But in its origin it represents the totality arising from the contributions of separate objects to that form of energy. Thus, having regard to its origin, a real atomic structure of each form of energy is discernible, so much from each objectified actual occasion; and only a finite number of actual occasions will be relevant.

This direct perception, characterized by mere subjective responsiveness and by lack of origination in the higher phases, exhibits the constitution of an actual entity under the guise of receptivity. In the language of causation, it describes the efficient causation operative in the actual world. In the language of epistemology, as framed by Locke, it describes how the ideas of particular existents are absorbed into the subjectivity of the percipient and are the datum for its experience of the external world. In the language of science, it describes how the quantitative intensity of localized energy bears in itself the vector marks of its origin, and the specialities of its specific forms; it also gives a reason for the atomic quanta to be discerned in the building up of a quantity of energy. In this way, the philosophy of organism—as it should—appeals to the facts.

SECTION V

The current accounts of perception are the stronghold of modern metaphysical difficulties. They have their origin in the same misunderstanding which led to the incubus of the substance-quality categories. The Greeks looked at a stone, and perceived that it was grey. The Greeks were ignorant of modern physics; but modern philosophers discuss perception in terms of categories derived from the Greeks.

The Greeks started from perception in its most elaborate and sophisticated form, namely, visual perception. In visual perception, crude perception is most completely made over by the originative phases in experience, phases which are especially prominent in human experience. If we wish to disentangle the two earlier prehensive phases—the receptive phases, namely, the datum and the subjective response—from the more advanced originative phases, we must consider what is common to all modes of perception, amid the bewildering variety of originative amplification.

On this topic I am content to appeal to Hume. He writes: 'But my senses convey to me only the impressions of coloured points, disposed in a certain manner. If *the eye is sensible* of anything further, I desire it may be pointed out to me.' * And again: 'It is universally allowed by the writers on optics, that *the eye* at all times sees an equal number of physical points, and that a man on the top of a mountain has no larger an image presented to his senses, than when he is cooped up in the narrowest court or chamber.' †

In each of these quotations Hume explicitly asserts that the *eye* sees. The conventional comment on such a passage is that Hume, for the sake of intelligibility, is using common forms of expression; that he is only really speaking of impressions on the mind; and that in the dim future, some learned scholar will gain reputation by emending 'eye' into 'ego.' The reason for citing the passages is to enforce the thesis that the form of speech is literary and intelligible because it expresses the ultimate truth of animal perception. The ultimate momentary 'ego' has as its datum the 'eye as experiencing such and such sights.' In the second quotation, the reference to the number of physical points is a reference to the excited area on the retina. Thus the 'eye as experiencing such and such sights' is passed on as a datum, from the cells of the retina, through the train of actual entities forming the relevant nerves, up to the brain. Any direct relation of eye to brain is entirely overshadowed by this intensity of indirect transmission. Of course this statement is merely a pale abstraction from the physiological theory of vision. But the physiological account does not pretend to be anything more than indirect inductive knowledge. The point here to be noticed is the immediate literary obviousness of 'the eye as experiencing such and such sights.' This is the very reason why Hume uses the expression in spite of his own philosophy. The conclusion, which the philosophy of organism draws, is that in human experience the fundamental fact of perception is the inclusion, in the datum, of the objectification of an antecedent part of the human body with such-and-such experiences. Hume agrees with this conclusion sufficiently well so as to argue from it, when it suits his purpose. He writes: 'I would fain ask those philosophers, who found so much of their reasonings on the distinction of substance and accident, and imagine we have

* Cf. *Treatise,* Part II, Sec. III. Italics not his.
† Cf. Part III, Sec. IX.

clear ideas of each, whether the idea of substance be derived from the impressions of sensation or reflection? If it be conveyed by our senses, I ask, which of them, and after what manner? If it be perceived by the eyes, it must be a colour; if by the ears, a sound; if by the palate, a taste; and so of the other senses.' *

We can prolong Hume's list: the feeling *of* the stone is *in the hand;* the feeling *of* the food is the ache *in the stomach;* the compassionate yearning is *in the bowels,* according to biblical writers; the feeling of well-being is in the viscera *passim;* ill temper is the emotional tone derivative from the disordered liver.

In this list, Hume's and its prolongation, for some cases—as in sight, for example—the supplementary phase in the ultimate subject overbalances in importance the datum inherited from the eye. In other cases, as in touch, the datum of 'the feeling in the hand' maintains its importance, however much the intensity, or even the character, of the feeling may be due to supplementation in the ultimate subject: this instance should be contrasted with that of sight. In the instance of the ache the stomach, as datum, is of chief importance, and the food though obscurely felt is secondary—at least, until the intellectual analysis of the situation due to the doctor, professional or amateur. In the instances of compassion, well-being, and ill temper, the supplementary feelings in the ultimate subject predominate, though there are obscure references to the bodily organs as inherited data.

This survey supports the view that the predominant basis of perception is perception of the various bodily organs, as passing on their experiences by channels of transmission and of enhancement. It is the accepted doctrine in physical science that a living body is to be interpreted according to what is known of other sections of the physical universe. This is a sound axiom; but it is double-edged. For it carries with it the converse deduction that other sections of the universe are to be interpreted in accordance with what we know of the human body.

It is also a sound rule that all interpretation should be based upon a *vera causa.* Now the original reliance upon 'the grey stone' has been shown by modern physics to be due to a misapprehension of a complex situation; but we have direct knowledge of the relationship of our central intelligence to our bodily feelings. According to this

* Cf. Part I, Sec. VI.

interpretation, the human body is to be conceived as a complex 'amplifier'—to use the language of the technology of electromagnetism. The various actual entities, which compose the body, are so coördinated that the experiences of any part of the body are transmitted to one or more central occasions to be inherited with enhancements accruing upon the way, or finally added by reason of the final integration. The enduring personality is the historic route of living occasions which are severally dominant in the body at successive instants. The human body is thus achieving on a scale of concentrated efficiency a type of social organization, which with every gradation of efficiency constitutes the orderliness whereby a cosmic epoch shelters in itself intensity of satisfaction.

The crude aboriginal character of direct perception is inheritance. What is inherited is feeling-tone with evidence of its origin: in other words, vector feeling-tone. In the higher grades of perception vague feeling-tone differentiates itself into various types of sensa—those of touch, sight, smell, etc.—each transmuted into a definite prehension of tonal contemporary nexūs by the final percipient.

SECTION VI

In principle, the animal body is only the more highly organized and immediate part of the general environment for its dominant actual occasion, which is the ultimate percipient. But the transition from without to within the body marks the passage from lower to higher grades of actual occasions. The higher the grade, the more vigorous and the more original is the enhancement from the supplementary phase. Pure receptivity and transmission give place to the trigger-action of life whereby there is release of energy in novel forms. Thus the transmitted datum acquires sensa enhanced in relevance or even changed in character by the passage from the low-grade external world into the intimacy of the human body. The datum transmitted from the stone becomes the touch-feeling in the hand, but it preserves the vector-character of its origin from the stone. The touch-feeling in the hand with this vector origin from the stone is transmitted to the percipient in the brain. Thus the final perception is the perception of the stone through the touch in the hand. In this perception the stone is vague and faintly relevant in comparison with the hand. But, however dim, it is there.

In the transmission of inheritance from A to B, to C, to D, A

is objectified by the eternal object S as a datum for B; where S is a sensum or a complex pattern of sensa. Then B is objectified for C. But the datum for B is thereby capable of some relevance for C, namely, A as objectified for B becomes reobjectified for C; and so on to D, and throughout the line of objectifications. Then for the ultimate subject M the datum includes A as thus transmitted, B as thus transmitted, and so on. The final objectifications for M are effected by a set S_1 of eternal objects which is a modification of the original group S. The modification consists partly in relegation of elements into comparative irrelevance, partly in enhancement of relevance for other elements, partly in supplementation by eliciting into important relevance some eternal objects not in the original S. Generally there will be vagueness in the distinction between A, and B, and C, and D, etc., in their function as components in the datum for M. Some of the line, A and C for instance, may stand out with distinctness by reason of some peculiar feat of original supplementation which retains its undimmed importance in subsequent transmission. Other members of the chain may sink into oblivion. For example, in touch there is a reference to the stone in contact with the hand, and a reference to the hand; but in normal, healthy, bodily operations the chain of occasions along the arm sinks into the background, almost into complete oblivion. Thus M, which has some analytic consciousness of its datum, is conscious of the feeling in its hand as the hand touches the stone. According to this account, perception in its primary form is consciousness of the causal efficacy of the external world by reason of which the percipient is a concrescence from a definitely constituted datum. The vector character of the datum is this causal efficacy.

Thus perception, in this primary sense, is perception of the settled world in the past as constituted by its feeling-tones, and as efficacious by reason of those feeling-tones. Perception, in this sense of the term, will be called 'perception in the mode of causal efficacy.' Memory is an example of perception in this mode. For memory is perception relating to the data from some historic route of ultimate percipient subjects M_1, M_2, M_3, etc., leading up to M which is the memorizing percipient.

SECTION VII

It is evident that 'perception in the mode of causal efficacy' is not that sort of perception which has received chief attention in the

philosophical tradition. Philosophers have disdained the information about the universe obtained through their visceral feelings, and have concentrated on visual feelings.

What we ordinarily term our visual perceptions are the result of the later stages in the concrescence of the percipient occasion. When we register in consciousness our visual perception of a grey stone, something more than bare sight is meant. The 'stone' has a reference to its past, when it could be used as missile if small enough, or as a seat if large enough. A 'stone' has certainly a history, and probably a future. It is one of the elements in the actual world which has got to be referred to as an actual region and not as an abstract potentiality. But we all know that the mere sight involved, in the perception of the grey stone, is the sight of a grey shape contemporaneous with the percipient, and with certain spatial relations to the percipient, more or less vaguely defined. Thus the mere sight is confined to the illustration of the geometrical perspective relatedness, of a certain contemporary spatial region, to the percipient, the illustration being effected by the mediation of 'grey.' The sensum 'grey' rescues that region from its vague confusion with other regions.

Perception which merely, by means of a sensum, rescues from vagueness a contemporary spatial region, in respect to its spatial shape and its spatial perspective from the percipient, will be called 'perception in the mode of presentational immediacy.'

Perception in this mode has already been considered in Part II, Chapter II. A more elaborate discussion of it can now be undertaken.* The definition, which has just been given, extends beyond the particular case of sight. The unravelling of the complex interplay between the two modes of perception—causal efficacy and presentational immediacy—is one main problem of the theory of perception.† The ordinary philosophical discussion of perception is almost wholly concerned with this interplay, and ignores the two pure modes which are essential for its proper explanation. The interplay between the two modes will be termed 'symbolic reference.'

Such symbolic reference is so habitual in human experience that great care is required to distinguish the two modes. In order to find

* Also subsequent discussions in Parts III and IV, *Process and Reality*.

† Cf. my Barbour-Page lectures, *Symbolism, Its Meaning and Importance*, delivered at the University of Virginia (April, 1927, Macmillan). Another discussion of this question is there undertaken, with other illustrations. Cf. also Professor Norman Kemp Smith's *Prolegomena to an Idealist Theory of Knowledge* (Macmillan, 1924).

obvious examples of the pure mode of causal efficacy we must have recourse to the viscera and to memory; and to find examples of the pure mode of presentational immediacy we must have recourse to so-called 'delusive' perceptions. For example, the image of a grey stone as seen in a mirror illustrates the space behind the mirror; the visual delusions arising from some delirium, or some imaginative excitement, illustrate surrounding spatial regions; analogously for the double-vision due to maladjustment of the eyes; the sight at night, of the stars and nebulae and Milky Way, illustrates vague regions of the contemporary sky; the feelings in amputated limbs illustrate spaces beyond the actual body; a bodily pain, referred to some part not the cause of the disorder, illustrates the painful region though not the pain-giving region. All these are perfectly good examples of the pure mode of presentational immediacy.

The epithet 'delusive,' which fits many, if not all, of these examples of presentational immediacy, is evidence that the mediating eternal object is not to be ascribed to the donation of the perceived region. It must have acquired its ingression in this mode from one of the originative phases of the percipient occasion. To this extent, the philosophy of organism is in agreement with the seventeenth-century doctrine of primary and secondary qualities, the mediating eternal object being, in this mode of ingression, a secondary quality. But in the philosophy of organism the doctrine does not have the consequences which follow in the earlier philosophies.

The account of perception in the pure mode of presentational immediacy, which has just been given, agrees absolutely with Descartes' doctrine of perception in general, so far as can be judged from his arguments which presuppose perception, and putting aside a few detached passages wherein he comes near to the doctrine of 'objectification' and near to Locke's second doctrine of 'ideas determined to particular existents.' Anyhow, his conclusion immediately follows that, in perception, thus described, all that is perceived is that the object has extension and is implicated in a complex of extensive relatedness with the animal body of the percipient. Part of the difficulties of the Cartesian philosophy, and of any philosophy which accepts this account as a complete account of perception, is to explain how we know more than this meagre fact about the world although our only avenue of direct knowledge limits us to this barren residuum. Also, if this be all that we perceive about the physical world,

we have no basis for ascribing the origination of the mediating sensa to any functioning of the human body. We are thus driven to the Cartesian duality of substances, bodies and minds. Perception is to be ascribed to mental functioning in respect to the barren extensive universe. We have already done violence to our immediate conviction by thus thrusting the human body out of the story; for, as Hume himself declares, we know that we see *by our eyes,* and taste *by our palates.* But when we have gone so far, it is inevitable to take a further step, and to discard our other conviction that we are perceiving a world of actual things within which we find ourselves. For a barren, extensive world is not really what we mean. We thus reduce perceptions to consciousness of impressions on the mind, consisting of sensa with 'manners' of relatedness. We then come to Hume, and to Kant. Kant's philosophy is an endeavour to retrieve some meaning for the two convictions which we have successively discarded. We have noted that Locke wavers in his account of perception, so that in the earlier portion of his *Essay* he agrees with Hume, and in the later portion with the philosophy of organism. We have also noted that Hume is inconsistent to the extent of arguing from a conviction which is discarded in his philosophy.

SECTION VIII

Presentational immediacy illustrates the contemporary world in respect to its potentiality for extensive subdivision into atomic actualities and in respect to the scheme of perspective relationships which thereby eventuates. But it gives no information as to the actual atomization of this contemporary 'real potentiality.' By its limitations it exemplifies the doctrine, already stated above, that the contemporary world happens independently of the actual occasion with which it is contemporary. This is in fact the definition of contemporaneousness (cf. Part II, Ch. II, Sec. I); namely, that actual occasions, A and B, are mutually contemporary, when A does not contribute to the datum for B, and B does not contribute to the datum for A, except that both A and B are atomic regions in the potential scheme of spatio-temporal extensiveness which is a datum for both A and B.

Hume's polemic respecting causation is, in fact, one prolonged, convincing argument that pure presentational immediacy does not disclose any causal influence, either whereby one actual entity is

constitutive of the percipient actual entity, or whereby one perceived actual entity is constitutive of another perceived actual entity. The conclusion is that, in so far as concerns their disclosure by presentational immediacy, actual entities in the contemporary universe are causally independent of each other.

The two pure modes of perception in this way disclose a variety of loci defined by reference to the percipient occasion *M*. For example, there are the actual occasions of the settled world which provide the datum for *M;* these lie in *M's* causal past. Again, there are the potential occasions for which *M* decides its own potentialities of contribution to their data; these lie in *M's* causal future. There are also those actual occasions which lie neither in *M's* causal past, nor in *M's* causal future. Such actual occasions are called *M's* 'contemporaries.' These three loci are defined solely by reference to the pure mode of causal efficacy.

We now turn to the pure mode of presentational immediacy. One great difference from the previous ways of obtaining loci at once comes into view. In considering the causal mode, the past and the future were defined positively, and the contemporaries of *M* were defined negatively as lying neither in *M's* past nor in *M's* future. In dealing with presentational immediacy the opposite way must be taken. For presentational immediacy gives positive information only about the immediate present as defined by itself. Presentational immediacy illustrates, by means of sensa, potential subdivisions within a cross-section of the world, which is in this way objectified for *M*. This cross-section is *M's* immediate present. What is in this way illustrated is the potentiality for subdivision into actual atomic occasions; we can also recognize potentialities for subdivision of regions whose subdivisions remain unillustrated by any contrast of sensa. There are well-known limitations to such direct perceptions of unillustrated potentiality, a perception outrunning the real illustration of division by contrasted sensa. Such limitations constitute the *minima sensibilia*.

Hume's polemic respecting causation constitutes a proof that *M's* 'immediate present' lies within the locus of *M's* contemporaries. The presentation to *M* of this locus, forming its immediate present, contributes to *M's* datum two facts about the universe: one fact is that there is a 'unison of becoming,' constituting a positive relation of

all the occasions in this community to any one of them. The members of this community share in a common immediacy; they are in 'unison' as to their becoming: that is to say, any pair of occasions in the locus are contemporaries. The other fact is the subjective illustration of the potential extensive subdivision with complete vagueness respecting the actual atomization. For example, the stone, which in the immediate present is a group of many actual occasions, is illustrated as one grey spatial region. But, to go back to the former fact, the many actual entities of the present stone and the percipient are connected together in the 'unison of immediate becoming.' This community of concrescent occasions, forming *M's* immediate present, thus establishes a principle of common relatedness, a principle realized as an element in *M's* datum. This is the principle of mutual relatedness in the 'unison of becoming.' But this mutual relatedness is independent of the illustration by those sensa, through which presentational immediacy for *M* is effected. Also the illustration by these sensa has unequal relevance for *M,* throughout the locus. In its spatially remote parts it becomes vaguer and vaguer, fainter and fainter; and yet the principle of 'unison of becoming' still holds, in despite of the fading importance of the sensa. We thus find that the locus—namely, *M's* immediate present—is determined by the condition of 'mutual unison' independently of variations of relevant importance in *M's* illustrative sensa, and extends to their utmost bounds of faintness, and is equally determinate beyond such bounds. We thus gain the conception of a locus in which any two atomic actualities are in 'concrescent unison,' and which is particularized by the fact that *M* belongs to it, and so do all actual occasions belonging to extensive regions which lie in *M's* immediate present as illustrated by importantly relevant sensa. This complete region is the prolongation of *M's* immediate present beyond *M's* direct perception, the prolongation being effected by the principle of 'concrescent unison.'

A complete region, satisfying the principle of 'concrescent unison,' will be called a 'duration.' A duration is a cross-section of the universe; it is the immediate present condition of the world at some epoch, according to the old 'classical' theory of time—a theory never doubted until within the last few years. It will have been seen that the philosophy of organism accepts and defines this notion. Some measure of acceptance is imposed upon metaphysics. If the notion

be wholly rejected no appeal to universal obviousness of conviction can have any weight; since there can be no stronger instance of this force of obviousness.

The 'classical' theory of time tacitly assumed that a duration included the directly perceived immediate present of each one of its members. The converse proposition certainly follows from the account given above, that the immediate present of each actual occasion lies in a duration. An actual occasion will be said * to be 'congredient with' or 'stationary in' the duration including its directly perceived immediate present. The actual occasion is included in its own immediate present; so that each actual occasion through its percipience in the pure mode of presentational immediacy—if such percipience has important relevance—defines one duration in which it is included. The percipient occasion is 'stationary' in this duration.

But the classical theory also assumed the converse of this statement. It assumed that any actual occasion only lies in one duration; so that if *N* lies in the duration including *M's* immediate present, then *M* lies in the duration including *N's* immediate present. The philosophy of organism, in agreement with recent physics, rejects this conversion; though it holds that such rejection is based on scientific examination of our cosmic epoch, and not on any more general metaphysical principle. According to the philosophy of organism, in the present cosmic epoch only one duration includes all *M's* immediate present; this one duration will be called *M's* 'presented duration.' But *M* itself lies in many durations; each duration including *M* also includes some portions of *M's* presented duration. In the case of human perception practically all the important portions are thus included; also in human experience the relationship to such durations is what we express by the notion of 'movement.'

To sum up this discussion. In respect to any one actual occasion *M* there are three distinct nexūs of occasions to be considered:

(i) The nexus of *M's* contemporaries, defined by the characteristic that *M* and any one of its contemporaries happen in causal independence of each other.

(ii) Durations including *M*; any such duration is defined by the characteristic that any two of its members are contemporaries. (It follows that any member of such a duration is contemporary with

* Cf. my *Principles of Natural Knowledge*, Ch. XI, and my *Concept of Nature*, Ch. V.

M, and thence that such durations are all included in the locus (i). The characteristic property of a duration is termed 'unison of becoming.')

(iii) *M's* presented locus, which is the contemporary nexus perceived in the mode of presentational immediacy, with its regions defined by sensa. It is assumed, on the basis of direct intuition, that *M's* presented locus is closely related to some one duration including *M*. It is also assumed, as the outcome of modern physical theory, that there is more than one duration including *M*. The single duration which is so related to *M's* presented locus is termed *'M's* presented duration.' But this connection is criticized in the following sections of this chapter. In Part IV,* the connection of these 'presented' loci to regions defined by straight lines is considered in more detail; the notion of 'strain loci' is there introduced.

SECTION IX

Physical science has recently arrived at the stage in which the practical identification, made in the preceding section, between the 'presented locus' of an actual entity, and a locus in 'unison of becoming' with the actual entity must be qualified.

The two notions, 'presented locus' and 'unison of becoming,' are distinct. The identification merely rests on the obvious experience of daily life. In any recasting of thought it is obligatory to include the identification as a practical approximation to the truth, sufficient for daily life. Subject to this limitation, there is no reason for rejecting any distinction between them which the evidence suggests.

In the first place, the presented locus is defined by some systematic relation to the human body—so far as we rely, as we must, upon human experience. A certain state of geometrical strain in the body, and a certain qualitative physiological excitement in the cells of the body, govern the whole process of presentational immediacy. In sense-perception the whole function of antecedent occurrences outside the body is merely to excite these strains and physiological excitements within the body. But any other means of production would do just as well, so long as the relevant states of the body are in fact produced. The perceptions are functions of the bodily states. The geometrical details of the projected sense-perception depend on the geometrical strains in the body, the qualitative sensa depend on

* *Process and Reality.*

the physiological excitements of the requisite cells in the body.

Thus the presented locus must be a locus with a systematic geometrical relation to the body. According to all the evidence, it is completely independent of the contemporary actualities which in fact make up the nexus of actualities in the locus. For example, we see a picture on the wall with direct vision. But if we turn our back to the wall, and gaze into a good mirror, we see the same sight as an image behind the mirror. Thus, given the proper physiological state of the body, the locus presented in sense-perception is independent of the details of the actual happenings which it includes. This is not to say, that sense-perception is irrelevant to the real world. It demonstrates to us the real extensive continuum in terms of which these contemporary happenings have their own experiences qualified. Its additional information in terms of the qualitative sensa has relevance in proportion to the relevance of the immediate bodily state to the immediate happenings throughout the locus. Both are derived from a past which is practically common to them all. Thus there is always some relevance; the correct interpretation of this relevance is the art of utilizing the perceptive mode of presentational immediacy as a means for understanding the world as a medium.

But the question which is of interest for this discussion is how this systematic relevance, of body to presented locus, is definable. This is not a mere logical question. The problem is to point out that element in the nature of things constituting such a geometrical relevance of the body to the presented locus. If there be such an element, we can understand that a certain state of the body may lift it into an important factor of our experience.

The only possible elements capable of this extended *systematic* relevance beyond the body are straight lines and planes. Planes are definable in terms of straight lines, so that we can concentrate attention upon straight lines.

It is a dogma of science that straight lines are not definable in terms of mere notions of extension. Thus, in the expositions of recent physical theory, straight lines are defined in terms of the actual physical happenings. The disadvantage of this doctrine is that there is no method of characterizing the possibilities of physical events antecedently to their actual occurrence. It is easy to verify that in fact there is a tacit relevance to an underlying system, by reference to which the physical loci—including those called 'straight

lines'—are defined. The question is how to define this underlying system in terms of 'pure' straight lines, determinable without reference to the casual details of the happenings.

It will be shown later * that this dogma of the indefinability of straight lines is mistaken. Thus the *systematic* relation of the body to the presented locus occasions no theoretical difficulty.

All measurement is effected by observations of sensa with geometrical relations within this presented locus. Also all scientific observation of the unchanged character of things ultimately depend upon the maintenance of directly observed geometrical analogies within such loci.

However far the testing of instruments is carried, finally all scientific interpretation is based upon the assumption of directly observed unchangeability of some instrument for seconds, for hours, for months, for years. When we test this assumption we can only use another instrument; and there cannot be an infinite regress of instruments.

Thus ultimately all science depends upon direct observation of homology of status within a system. Also the observed system is the complex of geometrical relations within some presented locus.

In the second place, a locus of entities in 'unison of becoming' obviously depends on the particular actual entities. The question, as to how the extensive continuum is in fact atomized by the atomic actualities, is relevant to the determination of the locus. The factor of temporal endurance selected for any one actuality will depend upon its initial 'subjective aim.' The categoreal conditions which govern the 'subjective aim' are discussed later in Part III. They consist generally in satisfying some condition of a maximum, to be obtained by the transmission of inherited types of order. This is the foundation of the 'stationary' conditions in terms of which the ultimate formulations of physical science can be mathematically expressed.

Thus the loci of 'unison of becoming' are only determinable in terms of the actual happenings of the world. But the conditions which they satisfy are expressed in terms of measurements derived from the qualification of actualities by the systematic character of the extensive continuum.

The term 'duration' will be used for a locus of 'unison of becom-

* Cf. Part IV, Chs. III and IV, *Process and Reality*.

ing,' and the terms 'presented locus' and 'strain locus' for the systematic locus involved in presentational immediacy.*

The strain loci provide the systematic geometry with its homology of relations throughout all its regions; the durations share in the deficiency of homology characteristic of the physical field which arises from the peculiarities of the actual events.

SECTION X

We can now sum up this discussion of organisms, order, societies, nexūs.

The aim of the philosophy of organism is to express a coherent cosmology based upon the notions of 'system,' 'process,' 'creative advance into novelty,' *'res vera'* (in Descartes' sense), 'stubborn fact,' 'individual unity of experience,' 'feeling,' 'time as perpetual perishing,' 'endurance as re-creation,' 'purpose,' 'universals as forms of definiteness,' 'particulars—i.e. *rēs verae*—as ultimate agents of stubborn fact.'

Every one of these notions is explicitly formulated either by Descartes or by Locke. Also no one can be dropped without doing violence to common sense. But neither Descartes nor Locke weaves these notions into one coherent system of cosmology. In so far as either philosopher is systematic, he relies on alternative notions which in the end lead to Hume's extreme of sensationalism.

In the philosophy of organism it is held that the notion of 'organism' has two meanings, interconnected but intellectually separable, namely, the microscopic meaning and the macroscopic meaning. The microscopic meaning is concerned with the formal constitution of an actual occasion, considered as a process of realizing an individual unity of experience. The macroscopic meaning is concerned with the givenness of the actual world, considered as the stubborn fact which at once limits and provides opportunity for the actual occasion. The canalization of the creative urge, exemplified in its massive reproduction of social nexūs, is for common sense the final illustration of the power of stubborn fact. Also in our experience, we essentially arise out of our bodies which are the stubborn facts of the immediate relevant past. We are also carried on by our immediate past of personal experience; we finish a sentence *because* we have begun it. The sentence may embody a new thought, never

* In *The Concept of Nature* these two loci were not discriminated, namely, durations and strain loci.

phrased before, or an old one rephrased with verbal novelty. There need be no well-worn association between the sounds of the earlier and the later words. But it remains remorselessly true, that we finish a sentence *because* we have begun it. We are governed by stubborn fact.

It is in respect to this 'stubborn fact' that the theories of modern philosophy are weakest. Philosophers have worried themselves about remote consequences, and the inductive formulations of science. They should confine attention to the rush of immediate transition. Their explanations would then be seen in their native absurdity.

CHAPTER V *LOCKE AND HUME*

SECTION I

A more detailed discussion of Descartes, Locke, and Hume—in this and in the succeeding chapter—may make plain how deeply the philosophy of organism is founded on seventeenth-century thought and how at certain critical points it diverges from that thought.

We shall understand better the discussion, if we start with some analysis of the presuppositions upon which Hume's philosophy rests. These presuppositions were not original to Hume, nor have they ceased with him. They were largely accepted by Kant and are widely prevalent in modern philosophy. The philosophy of organism can be best understood by conceiving it as accepting large portions of the expositions of Hume and Kant, with the exception of these presuppositions, and of inferences directly derived from them. Hume is a writer of unrivalled clearness; and, as far as possible, it will be well to allow him to express his ideas in his own words. He writes: 'We may observe, that it is universally allowed by philosophers, and is besides pretty obvious of itself, that nothing is ever really present with the mind but its perceptions or impressions and ideas, and that external objects become known to us only by those perceptions they occasion. To hate, to love, to think, to feel, to see; all this is nothing but to perceive.' * Again: 'All the perceptions of the human mind

* *Treatise,* Part II, Sec. VI.

resolve themselves into two distinct kinds, which I shall call *impressions* and *ideas*. The difference betwixt these consists in the degrees of force and liveliness with which they strike upon the mind, and make their way into our thought or consciousness. Those perceptions which enter with most force and violence, we may name *impressions;* and, under this name, I comprehend all our sensations, passions, and emotions, as they make their first appearance in the soul. By *ideas,* I mean the faint images of these in thinking and reasoning; such as, for instance, are all the perceptions excited by the present discourse, excepting only those which arise from the sight and touch, and excepting the immediate pleasure or uneasiness it may occasion.' *

The exceptions made in the above quotation are, of course, due to the fact that the 'perceptions' arising in these excepted ways are 'impressions' and not 'ideas.' Hume immediately draws attention to the fact that he deserts Locke's wide use of the term 'idea,' and restores it to its more usual and narrow meaning. He divides both ideas and impressions into 'simple' and 'complex.' He then adds: '. . . we shall here content ourselves with establishing one general proposition, *That all our simple ideas in their first appearance are derived from simple impressions, which are correspondent to them, and which they exactly represent.*' †

When Hume passes on to complex impressions and ideas, his admirable clearness partially deserts him. He fails to distinguish sufficiently between (i) the *'manner'* (or *'order'*) in which many simples constitute some one complex perception, i.e. impression or idea; and (ii) the *efficacious fact* by reason of which this complex perception arises; and (iii) the mere multiplicity of simples which constitute the complex perception in this definite *manner*. In this respect Hume's followers only differ from Hume by discarding some of that clarity which never wholly deserts him. Each one of these three notions is an essential element in his argument. He writes: '. . . we may conclude with certainty, that the idea of extension is nothing but a copy of these colored points, and of the manner of their appearance.' †† Also he writes: 'Were ideas entirely loose and unconnected, chance alone would join them; and it is impossible

* Cf. *Treatise,* Part I, Sec. I
† *Ibid.*
†† Cf. *Treatise,* Part II, Sec. III.

the same simple ideas should fall regularly into complex ones (as they commonly do), without some bond of union among them, some associating quality, by which one idea naturally introduces another. This uniting principle among ideas is not to be considered as an inseparable connection; for that has been already * excluded from the imagination; nor yet are we to conclude, that without it the mind cannot join two ideas; for nothing is more free than that faculty; but we are only to regard it as a gentle force, which commonly prevails, and is the cause why, among other things, languages so nearly correspond to each other; Nature, in a manner, pointing out to every one those simple ideas, which are most proper to be united into a complex one.' † As a final quotation, to illustrate Hume's employment of the third notion, we have: 'The idea of a substance as well as that of a mode, is *nothing but a collection* of simple ideas, that are united by the imagination, and have a particular name assigned them. . . . But the difference betwixt these ideas consist in this, that the particular qualities, which form a substance, are commonly referred to an unknown *something* [italics Hume's], in which they are supposed to inhere; or granting this fiction should not take place, are at least supposed to be closely and inseparably connected by the relations of contiguity and causation. The effect of this is, that whatever new simple quality we discover to have the *same connection* with the rest, we immediately comprehend it among them, even though it did not enter into the first conception of the substance. . . . The *principle of union* being regarded as the chief part of the complex idea, gives entrance to whatever quality afterwards occurs, and is equally comprehended by it, as are the others, which first presented themselves. . . .' ††

In this last quotation, the phrase 'principle of union' is ambiguous as between 'manner' and 'efficacious' reason. In either sense, it is inconsistent with the phrase 'nothing but a collection,' which at the beginning of the quotation settles so simply the notion of 'substance.'

Returning to the first of this sequence of three quotations, we note that any particular 'manner' of composition must itself be a simple idea, or impression. For otherwise we require yet another 'manner'

* Cf. Hume's previous section.

† Cf. *Treatise,* Part I, Sec. IV.

†† Cf. *Treatise,* Part I, Sec. VI. Italics not in edition quoted, except where noted.

of composition for the original manner, and so on indefinitely. Thus there is either a vicious infinity or a final simple idea. But Hume admits that there are novel compound ideas which are not copies of compound impressions. Thus he should also admit that there is a novel simple idea conveying the novel 'manner,' which is not a copy of an impression. He has also himself drawn attention to another exception in respect to missing shades of colour in a graduated colour scheme. This exception cannot be restricted to colour, and must be extended to sound, and smell, and to all graduations of sensations. Thus Hume's proposition, that simple ideas are all copies of simple impressions, is subject to such considerable qualifications that it cannot be taken for an ultimate philosophical principle, at least not when enunciated in Hume's unguarded fashion. Hume himself, in the passage (Part I, Sec. IV) quoted above for its relevance to his doctrine of the association of ideas, says, '. . . for nothing is more free than that faculty (i.e. the imagination).' But he limits its freedom to the production of novel complex ideas, disregarding the exceptional case of missing shades. This question of imaginative freedom is obviously treated very superficially by Hume. Imagination is never very free: it does not seem to be limited to complex ideas, as asserted by him; but such freedom as it has in fact seems to establish the principle of the possibility of diverse actual entities with diverse grades of imaginative freedom, some more, some less, than the instances in question.

In this discussion of Hume's doctrine of imaginative freedom, two other points have been left aside. One such point is the difference between various grades of generic abstraction, for example, scarlet, red, colour, sense-datum, manner of connectedness of diverse sense-data. The other point is the contrast between 'simplicity' and 'complexity.' We may doubt whether 'simplicity' is ever more than a relative term, having regard to some definite procedure of analysis. I hold this to be the case; and by reason of this opinion find yet another reason for discarding Hume's doctrine which would debar imagination from the free conceptual production of any type of eternal objects, such as Hume calls 'simple.' But there is no such fact as absolute freedom; every actual entity possesses only such freedom as is inherent in the primary phase 'given' by its standpoint of relativity to its actual universe. Freedom, givenness, potentiality, are notions which presuppose each other and limit each other.

SECTION II

Hume, at the end of this passage on the connectedness of ideas, places the sentence '. . . Nature, in a manner, pointing out to every one those simple ideas, which are most *proper* to be *united* into a complex one.' Hume's philosophy is occupied with the double search, first, for manners of unity, whereby many simples become one complex impression; and secondly, for a standard of propriety by which to criticize the production of ideas.

Hume can find only one standard of propriety, and that is, *repetition*. Repetition is capable of more or less: the more often impressions are repeated, the more proper it is that ideas should copy them. Fortunately, and without any reason so far as Hume can discover, complex impressions, often repeated, are also often copied by their corresponding complex ideas.

Also the frequency of ideas following upon the frequency of their correlate impressions is also attended by an expectation of the repetition of the impression. Hume also believes, without any reason he can assign, that this expectation is pragmatically justified. It is this pragmatic justification, without metaphysical reason, which constitutes the propriety attaching to 'repetition.' This is the analysis of the course of thought involved in Hume's doctrine of the association of ideas in its relation to causation, and in Hume's final appeal to practice.

It is a great mistake to attribute to Hume any disbelief in the importance of the notion of 'cause and effect.' Throughout the *Treatise* he steadily affirms its fundamental importance; and finally, when he cannot fit it into his metaphysics, he appeals beyond his metaphysics to an ultimate justification outside any rational systematization. This ultimate justification is 'practice.'

Hume writes: 'As our senses show us in *one* instance two bodies, or motions, or qualities, in certain relations of succession and contiguity, so our *memory* presents us only with a *multitude* of instances wherein we always find like bodies, motions, or qualities, in like relations. From the mere *repetition* of any past impression, even to infinity, there never will arise any *new original idea,* such as that of a *necessary connection;* and the *number* of impressions has in this case no more effect than if we confined ourselves to *one only*. But though this reasoning seems just and obvious, yet, as it would be folly to

despair too soon, we shall continue the thread of our discourse; and having found, that after the discovery of the *constant conjunction* of any objects, we *always* draw an inference from one object to another, we shall now examine the nature of that inference, and of the transition from the impression to the idea. Perhaps it will appear in the end, that the necessary connection depends on the inference, instead of the inference's depending on the necessary connection. . . . The only connection or relation of objects which can lead us *beyond* the immediate impressions of our memory and senses, is that of *cause and effect;* and that because it is the only one on which we can found a just inference from one object to another. The idea of cause and effect is derived from *experience* [italics Hume's], which informs us, that such particular objects, in all past instances, have been constantly conjoined with each other; and as an object similar to one of these is supposed to be immediately present in its impression, we thence *presume* on the existence of one similar to its usual attendant. According to this account of things, which is, I think, in every point unquestionable, probability is founded on the presumption of a resemblance betwixt those objects of which we have had experience, and those of which we have had none; and, therefore, it is *impossible* that this *presumption* can arise from *probability.*' *

Hume's difficulty with 'cause and effect' is that it lies 'beyond the immediate impressions of our memory and senses.' In other words, this *manner* of connection is not given in any impression. Thus the whole basis of the idea, its propriety, is to be traced to the repetition of impressions. At this point of his argument, Hume seems to have overlooked the difficulty that 'repetition' stands with regard to 'impressions' in exactly the same position as does 'cause and effect.' Hume has confused a 'repetition of impressions' with an 'impression of repetitions of impressions.' In Hume's own words on another topic (Part II, Sec. V): 'For whence should it be derived? Does it arise from an impression of sensation or of reflection? Point it out distinctly to us, that we may know its nature and qualities. But if you cannot point out *any such impression* [Hume's italics], you may be certain you are mistaken, when you imagine you have *any such idea.*'

Hume's answer to this criticism would, of course, be that he admits

* Cf. *Treatise,* Part III, Sec. VI. Italics not in *Treatise.*

'memory.' But the question is what is consistent with Hume's own doctrine. This is Hume's doctrine of memory (cf. Part III, Sec. V): 'Since therefore the memory is known, neither by the order of its *complex* ideas, nor by the nature of its *simple* ones; it follows, that the difference betwixt it and the imagination lies in its superior force and vivacity.' But (in Part I, Sec. I) he writes: 'By *ideas* I mean the faint images of these [i.e. impressions] in thinking and reasoning,' and later on he expands 'faint' into 'degree of force and vivacity.' * Thus, purely differing in 'force and vivacity,' we have the order: impressions, memories, ideas.

This doctrine is very unplausible; and, to speak bluntly, is in contradiction to plain fact. But, even worse, it omits the vital character of memory, namely, that it is *memory*. In fact the whole notion of *repetition* is lost in the 'force and vivacity' doctrine. What Hume does explain is that with a number of different perceptions immediately concurrent, he sorts them out into three different classes according to force and vivacity. But the repetition character, which he ascribes to simple ideas, and which is the whole point of memory, finds no place in his explanation. Nor can it do so, without an entire recasting of his fundamental philosophic notions.

SECTION III

Hume's argument has become circular. In the beginning of his *Treatise,* he lays down the 'general proposition': 'That all our simple ideas in their first appearance, are derived from simple impressions, . . .' He proves this by an empirical survey. But the proposition itself employs—covertly, so far as language is concerned—the notion of 'repetition,' which itself is not an 'impression.' Again, later he finds 'necessary connection': he discards this because he can find no corresponding impression. But the original proposition was only founded on an empirical survey; so the argument for dismissal is purely circular. Further, if Hume had only attended to his own excellent Part II, Sec. VI, 'Of the Idea of Existence, and of External Existence,' he would have remembered that whatever we do think of, thereby in some sense 'exists.' Thus, having the idea of 'necessary

* This doctrine of 'force and vivacity' is withdrawn in the last sentence of Hume's Appendix to the *Treatise.* But the argument in the *Treatise* is substantially built upon it. In the light of the retraction the whole 'sensationalist' doctrine requires reconsideration. The withdrawal cannot be treated as a minor adjustment.

connection,' the only question is as to its exemplification in the connectedness of our 'impressions.' He muddles the importance of an idea with the fact of our entertainment of the idea. We cannot even be wrong in thinking that we think of 'necessary connection,' unless we *are* thinking of 'necessary connection.' Of course, we may be very wrong in believing that the notion is important.

The reasons for this examination of Hume, including the prolonged quotations, are (i) that Hume states with great clearness important aspects of our experience; (ii) that the defects in his statements are eminently natural defects which emerge with great clearness, owing to the excellence of his presentation; and (iii) that Hume differs from the great majority of his followers chiefly by the way in which he faces up to the problems raised by his own philosophy.

The first point to notice is that Hume's philosophy is pervaded by the notion of 'repetition,' and that memory is a particular example of this character of experience, that in some sense there is entwined in its fundamental nature the fact that it is repeating something. Tear 'repetition' out of 'experience,' and there is nothing left. On the other hand, 'immediacy,' or 'first-handedness,' is another element in experience. Feeling overwhelms repetition; and there remains the immediate, first-handed fact, which is the actual world in an immediate complex unity of feeling.

There is another contrasted pair of elements in experience, clustering round the notion of time, namely, 'endurance' and 'change.' Descartes, who emphasizes the notion of 'substance,' also emphasizes 'change.' Hume, who minimizes the notion of 'substance,' similarly emphasizes 'change.' He writes: 'Now as time is composed of parts that are not coexistent, an unchangeable object, since it produces none but coexistent impressions, produces none that can give us the idea of time; and, consequently, that idea must be derived from a succession of changeable objects, and time in its first appearance can never be severed from such a succession.' * Whereas Descartes writes: '. . . for this (i.e. "the nature of time or of the duration of things") is of such a kind that its parts do not depend one upon the other, and never co-exist; and from the fact that we now are, it does not follow that we shall be a moment afterwards, if some cause—the same that first produced us—does not continue so to produce us;

* Cf. *Treatise,* Part II, Sec. III.

that is to say, to conserve us.' And again: 'We shall likewise have a very different understanding of *duration, order,* and *number,* if in place of mingling with the idea that we have of them what properly speaking pertains to the conception of substance, we merely consider that the duration of each thing is a mode under which we shall consider this thing in so far as it continues to exist. . . .' *

We have certainly to make room in our philosophy for the two contrasted notions, one that every actual entity endures, and the other that every morning is a new fact with its measure of change.

These various aspects can be summed up in the statement that *experience* involves a *becoming,* that *becoming* means that *something becomes,* and that *what becomes* involves *repetition* transformed into *novel immediacy.*

This statement directly traverses one main presupposition which Descartes and Hume agree in stating explicitly. This presupposition is that of the individual independence of successive temporal occasions. For example, Descartes, in the passage cited above, writes: '(The nature of time) is such that its parts do not depend one upon the other. . . .' Also Hume's impressions are self-contained, and he can find no temporal relationship other than mere serial order. This statement about Hume requires qualifying so far as concerns the connection between 'impressions' and 'ideas.' There is a relation of 'derivation' of 'ideas' from 'impressions' which he is always citing and never discussing. So far as it is to be taken seriously—for he never refers it to a correlate 'impression'—it constitutes an exception to the individual independence of successive 'perceptions.' This presupposition of individual independence is what I have elsewhere † called, the 'fallacy of simple location.' The notion of 'simple location' is inconsistent with any admission of 'repetition'; Hume's difficulties arise from the fact that he starts with simple locations and ends with repetition. In the organic philosophy the notion of repetition is fundamental. The doctrine of objectification is an endeavor to express how what is settled in actuality is repeated under limitations, so as to be 'given' for immediacy. Later, in discussing 'time,' this doctrine will be termed the doctrine of 'objective immortality.'

* Cf. *Principles,* Part I, 21, and 55.
† Cf. *Science and the Modern World,* Ch. III.

SECTION IV

The doctrine of the individual independence of real facts is derived from the notion that the subject-predicate form of statement conveys a truth which is metaphysically ultimate. According to this view, an individual substance with its predicates constitutes the ultimate type of actuality. If there be one individual, the philosophy is monistic; if there be many individuals, the philosophy is pluralistic. With this metaphysical presupposition, the relations between individual substances constitute metaphysical nuisances: there is no place for them. Accordingly—in defiance of the most obvious deliverance of our intuitive 'prejudices'—every respectable philosophy of the subject-predicate type is monistic.

The exclusive dominance of the substance-quality metaphysics was enormously promoted by the logical bias of the mediaeval period. It was retarded by the study of Plato and of Aristotle. These authors included the strains of thought which issued in this doctrine, but included them inconsistently mingled with other notions. The substance-quality metaphysics triumphed with exclusive dominance in Descartes' doctrines. Unfortunately he did not realize that his notion of the *'res vera'* did not entail the same disjunction of ultimate facts as that entailed by the Aristotelian notion of 'primary substance.' Locke led a revolt from this dominance, but inconsistently. For him and also for Hume, in the background and tacitly presupposed in all explanations, there remained the mind with its perceptions. The perceptions, for Hume, are what the mind knows about itself; and tacitly the knowable facts are always treated as qualities of a subject—the subject being the mind. His final criticism of the notion of the 'mind' does not alter the plain fact that the whole of the previous discussion has included this presupposition. Hume's final criticism only exposes the metaphysical superficiality of his preceding exposition.

In the philosophy of organism a subject-predicate proposition is considered as expressing a high abstraction.

The metaphysical superiority of Locke over Hume is exhibited in his wide use of the term 'idea,' which Locke himself introduced and Hume abandoned. Its use marks the fact that his tacit subject-predicate bias is slight in its warping effect. He first (I, I, 8) explains: '. . . I have used it (i.e. idea) to express whatever is meant by

phantasm, notion, species, or whatever it is which the mind can be employed about in thinking. . . .' But later (III, III, 6 and 7), without any explicit notice of the widening of use, he writes: '. . . and ideas *become* * *general* by separating from them the circumstances of time, and place, and any other ideas that may *determine them to this or that particular existence.*' Here, for Locke, the operations of the mind originate from ideas 'determined' to particular existents. This is a fundamental principle with Locke; it is a casual concession to the habits of language with Hume; and it is a fundamental principle with the philosophy of organism. In an earlier section (II, XXIII, 1) Locke expresses more vaguely the same doctrine, though in this context he immediately waters it down into an unexplained notion of 'going constantly together': 'The mind, being, . . . furnished with a great number of the simple ideas conveyed in by the senses, as they are found *in exterior things,* . . . takes notice, also, that a certain number of these simple ideas *go constantly together.*'

But Locke wavers in his use of this principle of some sort of perception of 'particular existents'; and Hume seeks consistency by abandoning it; while the philosophy of organism seeks to reconstruct Locke by abandoning those parts of his philosophy which are inconsistent with this principle. But the principle itself is to be found plainly stated by Locke.

Hume has only impressions of 'sensation' and of 'reflection.' He writes: 'The first kind arises in the soul originally, from unknown causes.' † Note the tacit presupposition of 'the soul' as subject, and 'impression of sensation' as predicate. Also note the dismissal of any intrinsic relevance to a particular existent, which is an existent in the same sense as the 'soul' is an existent; whereas Locke illustrates his meaning by referring (cf. III, III, 7) to a 'child'—corresponding to 'the soul' in Hume's phrase—and to its 'nurse' *of whom* the child has its 'idea.'

Hume is certainly inconsistent, because he cannot entirely disregard common sense. But his inconsistencies are violent, and his main argument negates Locke's use. As an example of his glaring inconsistency of phraseology, note: 'As to those *impressions,* which arise from the senses, their ultimate cause is, in my opinion, per-

* Italics mine.

† *Treatise,* Part I, Sec. II.

fectly inexplicable by human reason, and it will always be impossible to decide with certainty, whether they arrive immediately from the object, or are produced by the creative power of the mind, or are derived from the Author of our being.' * Here he inconsistently speaks of *the object,* whereas he has nothing on hand in his philosophy which justifies the demonstrative word *'the.'* In the second reference *'the object'* has emerged into daylight. He writes: 'There is no object which implies the existence of any other, if we consider these objects in themselves, and never look beyond the ideas which we form of them.' This quotation exhibits an ingenious confusion whereby Hume makes the best of two metaphysical worlds, the world with Locke's principle, and his own world which is without Locke's principle.

But Locke's principle amounts to this: That there are many actual existents, and that in some sense one actual existent repeats itself in another actual existent, so that in the analysis of the latter existent a component 'determined to' the former existent is discoverable. The philosophy of organism expresses this principle by its doctrines of 'prehension' and of 'objectification.' Locke always supposes that consciousness is consciousness of the ideas in the conscious mind. But he never separates the 'ideas' from the 'consciousness.' The philosophy of organism makes this separation, and thereby relegates consciousness to a subordinate metaphysical position; and gives to Locke's *Essay* a metaphysical interpretation which was not in Locke's mind. This separation asserts Kant's principle: 'Gedanken ohne Inhalt sind leer, Anschauungen ohne Begriffe sind blind.' † But Kant's principle is here applied in exactly the converse way to Kant's own use of it. Kant is obsessed with the mentality of 'intuition,' and thence with its necessary involution in consciousness. This suppressed premise is 'Intuitions are never blind.'

SECTION V

In one important respect Hume's philosophical conceptions show a marked superiority over those of Locke. In the *Essay Concerning Human Understanding,* the emphasis is laid upon the morphological structure of 'human understanding.' The logical relationships of

* Cf. *Treatise,* Part III, Secs. V and VI.

† *Critique of Pure Reason,* Transcendental Logic, Intro. I.

various sorts of 'ideas' are examined. Now, whether in physics, biology, or elsewhere, morphology, in the sense of the analysis of logical relationships, constitutes the first stage of knowledge. It is the basis of the new 'mathematical' method which Descartes introduced. Morphology deals in analytical propositions, as they are termed by Kant. For example, Locke writes: 'The common names of substances, as well as other general terms, stand for sorts: *which* * *is nothing else but* the being made signs of such complex ideas, wherein several particular substances do or might agree, by virtue of which they are capable of being comprehended in one common conception, and be signified by one name.' And again: 'Our abstract ideas are to us the measures of species.' And again: 'Nor let any one say, that the power of propagation in animals by the mixture of male and female, and in plants by seeds, keeps the supposed real species distinct and entire.' † In technical language, Locke had no use for genetic evolution.

On the other hand, Hume's train of thought unwittingly emphasizes 'process.' His very scepticism is nothing but the discovery that there is something in the world which cannot be expressed in analytic propositions. Hume discovered that 'We murder to dissect.' He did not say this, because he belonged to the mid-eighteenth century; and so left the remark to Wordsworth. But, in effect, Hume discovered that an actual entity is at once a process, and is atomic; so that in no sense is it the sum of its parts. Hume proclaimed the bankruptcy of morphology.

Hume's account of the process discoverable in 'the soul' is as follows: first, impressions of sensation, of unknown origin; then, ideas of such impressions, 'derived from' the impressions; then, impressions of reflection 'derived from' the antecedent ideas; and then, ideas of impressions of reflection. Somewhere in this process there is to be found repetition of impressions, and thence by 'habit'—by which we may suppose that a particular mode of 'derivation' is meant—by habit, a repetition of the correlate ideas; and thence expectancy of the repetition of the correlate impressions. This expectancy would be an 'impression of reflection.' It is difficult to understand why Hume exempts 'habit' from the same criticism as that

* Italics mine.
† III, VI, 1, 22, 23.

applied to the notion of 'cause.' We have no 'impression' of 'habit,' just as we have no 'impression' of 'cause.' Cause, repetition, habit are all in the same boat.

Somewhat inconsistently, Hume never allows impressions of sensation to be derived from the correlate ideas; though, as the difference between them only consists in 'force and vivacity,' the reason for this refusal cannot be founded in his philosophy. The truth is that Hume retained an obstinate belief in an external world which his principles forbade him to confess in his philosophical constructions. He reserved that belief for his daily life, and for his historical and sociological writings, and for his *Dialogues Concerning Natural Religion*.

The merit of Hume's account is that the process described is within 'the soul.' In the philosophy of organism 'the soul' as it appears in Hume, and 'the mind' as it appears in Locke and Hume, are replaced by the phrases 'the actual entity,' and 'the actual occasion,' these phrases being synonymous.

Two defects, found equally in Locke and in Hume, are, first, the confusion between a Lockian 'idea' and consciousness of such an idea; and, secondly, the assigned relations between 'ideas' of sensation and 'ideas' of reflections. In Hume's language, this latter point is concerned with the relations between 'impressions of sensation' and 'impressions of reflection.' Hume and Locke, with the overintellectualist bias prevalent among philosophers, assume that emotional feelings are necessarily derivative from sensations. This is conspicuously not the case; the correlation between such feelings and sensations is on the whole a secondary effect. Emotions conspicuously brush aside sensations and fasten upon the 'particular' objects to which—in Locke's phrase—certain 'ideas' are *'determined.'* The confinement of our prehension of other actual entities to the mediation of private sensations is pure myth. The converse doctrine is nearer the truth: the more primitive mode of objectification is via emotional tone, and only in exceptional organisms does objectification, via sensation, supervene with any effectiveness. In their doctrine on this point, Locke and Hume were probably only repeating the mediaeval tradition, and they have passed on the tradition to their successors. None the less, the doctrine is founded upon no necessity of thought, and lacks empirical confirmation. If we consider the matter physiologically, the emotional tone depends mainly on the condition of the viscera which are peculiarly ineffective in generating sensations. Thus

the whole notion of prehension should be inverted. We prehend other actual entities more primitively by direct mediation of emotional tone, and only secondarily and waveringly by direct mediation of sense. The two modes fuse with important effects upon our perceptive knowledge. This topic must be reserved * for further discussion; but it is fundamental in the philosophy of organism. One difficulty in appealing to modern psychology, for the purpose of a preliminary survey of the nature of experience, is that so much of that science is based upon the presupposition of the sensationalist mythology. Thus the simpler, more naïve surveys of Locke and Hume are philosophically the more useful.

Later,† a 'prehension' will be analysed into 'prehending subject,' 'object prehended,' and 'subjective form.' The philosophy of organism follows Locke in admitting particular 'exterior things' into the category of 'object prehended.' It also follows Hume in his admission at the end of his Appendix to the *Treatise:* 'Had I said that two ideas of the same object can only be different by their different *feeling,* I should have been nearer the truth.' What Hume here calls 'feeling' is expanded in the philosophy of organism into the doctrine of 'subjective form.' But there is another ineradicable difference between some prehensions, namely, their diversity of prehending subjects, when the two prehensions are in that respect diverse. The subsequent uses of the term 'feeling' are in the sense of the 'positive' type of prehensions, and *not* in the sense in which Hume uses it in the above quotation.

The approximation of the philosophy of organism to Santayana's doctrine of 'animal faith' is effected by this doctrine of objectification by the mediation of 'feeling.'

Santayana would deny that 'animal faith' has in it any element of givenness. This denial is presumably made in deference to the sensationalist doctrine, that all knowledge of the external world arises by the mediation of private sensations. If we allow the term 'animal faith' to describe a kind of perception which has been neglected by the philosophic tradition, then practically the whole of Santayana's discussion †† is in accord with the organic philosophy.

The divergence from, and the analogy to, Santayana's doctrine can be understood by quoting two sentences: 'I propose therefore to use

* Parts III and IV.
† Part III, *Process and Reality.*
†† Cf. his *Scepticism and Animal Faith.*

the word existence . . . to designate not data of intuition but facts or events believed to occur in nature. These facts or events will include, first, intuitions themselves, or instances of consciousness, like pains and pleasures and all remembered experiences and mental discourse; and second, physical things and events, having a transcendent relation to the data of intuition which, in belief, may be used as signs for them; . . .'

It may be remarked in passing that this quotation illustrates Santayana's admirable clarity of thought, a characteristic which he shares with the men of genius of the seventeenth and eighteenth centuries. Now the exact point where Santayana differs from the organic philosophy in his implicit assumption that 'intuitions themselves' cannot be among the 'data of intuition,' that is to say, the data of other intuitions. This possibility is what Santayana denies and the organic philosophy asserts. In this respect Santayana is voicing the position which, implicitly or explicitly, pervades modern philosophy. He is only distinguished by his clarity of thought. If Santayana's position be granted, there is a phenomenal veil, a primitive credulity associated with action and valuation, and a mysterious symbolism from the veil to the realities behind the veil. The only difference between such philosophers lies in their reading of the symbolism, some read more and some less. There can be no decision between them, since there are no rational principles which penetrate from the veil to the dark background of reality.

The organic philosophy denies this doctrine because, first, it is contrary to naïve experience; secondly, 'memory' is a very special instance of an antecedent act of experience becoming a datum of intuition for another act of experience; thirdly, the rejected doctrine is derived from the misconception of Locke, already noted previously (cf. Part II, Ch. I, Sec. VI), that logical simplicity can be identified with priority in the concrescent process. Locke, in his first two Books, attempts to build up experience from the basic elements of simple 'ideas' of sensation. These simple ideas are practically Santayana's 'intuitions of essences.' Santayana explicitly repudiates the misconception, but in so doing he knocks away one of the supports of his doctrine. A fourth reason for the rejection of the doctrine is that the way is thereby opened for a rational scheme of cosmology in which a final reality is identified with acts of experience.

CHAPTER VI *FROM DESCARTES TO KANT*

SECTION I

A comparison of different ways in which Descartes and Locke respectively conceived the scope of their investigations at once discloses the very important shift which Locke introduced into the tradition of philosophic thought. Descartes asked the fundamental metaphysical question, What is it to be an actual entity? He found three kinds of actual entities, namely, cogitating minds, extended bodies, and God. His word for an actual entity was 'substance.' The fundamental proposition, whereby the analysis of actuality could be achieved, took the form of predicating a quality of the substance in question. A quality was either an accident or an essential attribute. In the Cartesian philosophy there was room for three distinct kinds of change: one was the change of accidents of an enduring substance; another was the origination of an individual substance; and the third was the cessation of the existence of an enduring substance. Any individual belonging to either of the first two kinds of substances did not require any other individual of either of these kinds in order to exist. But it did require the concurrence of God. Thus the essential attributes of a mind were its dependence on God and its cogitations; and the essential attributes of a body were its dependence on God and its extension. Descartes does not apply the term 'attribute' to the 'dependence on God'; but it is an essential element in his philosophy. It is quite obvious that the accidental relationships between diverse individual substances form a great difficulty for Descartes. If they are to be included in his scheme of the actual world, they must be qualities of a substance. Thus a relationship is the correlation of a pair of qualities one belonging exclusively to one individual, and the other exclusively to the other individual. The correlation itself must be referred to God as one of his accidental qualities. This is exactly Descartes' procedure in his theory of representative ideas. In this theory, the perceived individual has one quality; the perceiving individual has another quality which is the 'idea' representing this quality; God is aware of the correlation; and the perceiver's knowledge of God guarantees for him the veracity of his idea. It is unneces-

sary to criticize this very artificial account of what common sense believes to be our direct knowledge of other actual entities. But it is the only account consistent with the metaphysical materials provided by Descartes, combined with his assumption of a multiplicity of actual entities. In this assumption of a multiplicity of actual entities the philosophy of organism follows Descartes. It is however obvious that there are only two ways out of Descartes' difficulties; one way is to have recourse to some form of monism; the other way is to reconstruct Descartes' metaphysical machinery.

But Descartes asserts one principle which is the basis of all philosophy: he holds that the whole pyramid of knowledge is based upon the immediate operation of knowing, which is either an essential (for Descartes), or a contributory, element in the composition of an immediate actual entity. This is also a first principle for the philosophy of organism. But Descartes allowed the subject-predicate form of proposition, and the philosophical tradition derived from it, to dictate his subsequent metaphysical development. For his philosophy, 'actuality' meant 'to be a substance with inhering qualities.' For the philosophy of organism, the percipient occasion is its own standard of actuality. If in its knowledge other actual entities appear, it can only be because they conform to its standard of actuality. There can only be evidence of a world of actual entities, if the immediate actual entity discloses them as essential to its own composition. Descartes' notion of an unessential experience of the external world is entirely alien to the organic philosophy. This is the root point of divergence; and is the reason why the organic philosophy has to abandon any approach to the substance-quality notion of actuality. The organic philosophy interprets experience as meaning the 'self-enjoyment of being one among many, and of being one arising out of the composition of many.' Descartes interprets experiences as meaning the self-enjoyment, by an individual substance, of its qualification by ideas.

SECTION II

Locke explicitly discards metaphysics. His enquiry has a limited scope: 'This therefore being my purpose, to inquire into the original, certainty and extent of human knowledge, together with the grounds and degrees of belief, opinion, and assent, I shall not at present meddle with the physical consideration of the mind, or trouble myself to examine wherein its essence consists, . . . It shall suffice to

my present purpose, to consider the discerning faculties of a man as they are employed about the objects which they have to do with; . . .' * The enduring importance of Locke's work comes from the candour, clarity, and adequacy with which he stated the evidence, uninfluenced by the bias of metaphysical theory. He explained, in the sense of stating plainly, and not in the more usual sense of 'explaining away.' By an ironic development in the history of thought, Locke's successors, who arrogated to themselves the title of 'empiricists,' have been chiefly employed in explaining away the obvious facts of experience in obedience to the a priori doctrine of sensationalism, inherited from the medieval philosophy which they despised. Locke's *Essay* is the invaluable storehouse for those who wish to confront their metaphysical constructions by a recourse to the facts.

Hume clipped his explanation by this a priori theory, which he states explicitly in the first quotation made from his *Treatise* in the previous chapter. It cannot be too often repeated: 'We may observe, that it is universally allowed by philosophers, and is besides pretty obvious of itself, that nothing is ever really present with the mind but its perceptions or impressions and ideas, and that external objects become known to us only by those perceptions they occasion. To hate, to love, to think, to feel, to see; all this is nothing but to perceive.

Hume, in agreement with what 'is universally allowed by philosophers,' interprets this statement in a sensationalist sense. In accordance with this sense, an impression is nothing else than a particular instance of the mind's awareness of a universal, which may either be simple, or may be a manner of union of many simple universals. For Hume, hating, loving, thinking, feeling, are nothing but perceptions derivate from these fundamental impressions. This is the a priori sensationalist dogma, which bounds all Hume's discoveries in the realm of experience. It is probable that this dogma was in Locke's mind throughout the earlier portion of his *Essay*. But Locke was not seeking consistency with any a priori dogma. He also finds in experience 'ideas' with characteristics which 'determine them to this or that particular existent.' Such inconsistency with their dogma shocks empiricists, who refuse to admit experience, naked and unashamed, devoid of their a priori figleaf. Locke is merely stating what, in practice,

* Cf. *Essay*, I, I, 2.

nobody doubts. But Locke would have agreed with Hume in refusing to admit that 'ideas of reflection' may be directly 'determined to some particular existent,' without the intervention of 'ideas of sensation.' In this respect, Locke was a sensationalist, and the philosophy of organism is not sensationalist. But Locke's avoidance of metaphysics only led him up to a stage of thought for which metaphysics is essential to clarity. The questions as to the status of a 'particular existent,' and of an 'idea determined to a particular existent,' demand metaphysical discussion. Locke is never tired of disparaging the notion of 'substance'; but he gives no hint of alternative categories which he would employ to analyse the notions of an 'actual entity' and of 'reality.' But his *Essay,* however, does contain a line of thought which can be developed into a metaphysic. In the first place, he distinctly holds that ideas of particular existents—for example, the child's idea of its mother—constitute the fundamental data which the mental functioning welds into a unity by a determinate process of absorption, including comparison, emphasis, and abstraction. He also holds that 'powers' are to be ascribed to particular existents whereby the constitutions of other particulars are conditioned. Correlatively, he holds that the constitutions of particular existents must be described so as to exhibit their 'capacities' for being conditioned by such 'powers' in other particulars. He also holds that all qualities have in some sense a relational element in them. Perhaps, though Locke does not say so, this notion of the relational element in qualities is illustrated in the following passage: 'Besides, there is scarce any particular thing existing, which, in some of its simple ideas, does not communicate with a greater, and in others with a less, number of particular beings: . . .' * Locke here expresses the notion of an identity between two simple ideas in the form of a 'communication' between the particular existents which possess that common quality. This passage also illustrates Locke's habit of employing the term 'idea' in a sense other than particular content of an act of awareness. Finally, Locke's notion of the passage of time is that something is 'perpetually perishing.' If he had grasped the notion that the actual entity 'perishes' in the passage of time, so that no actual entity changes, he would have arrived at the point of view of the philosophy of organism. What he does say, is 'perpetually perishing parts of succession.' * Here, as elsewhere, Locke's neglect

* Cf. *Essay,* III, IX, 14.

of ultimate questions revenges itself upon him. Nothing can make the various parts of his *Essay* mutually consistent. He never revises the substance-quality categories which remain presupposed throughout his *Essay*. In the first two books of the *Essay*, he professes to lay the foundations of his doctrine of ideas. These books are implicitly dominated by the notion of the ideas as mere qualifications of the substrate mind. In the third book of the *Essay* he is apparently passing on to the application of his established doctrine of ideas to the subordinate question of the function of language. But he tacitly introduces a new doctrine of ideas, which is difficult to conciliate with the sensationalist doctrine of the preceding books. Hume concentrates upon the doctrine of Locke's earlier books; the philosophy of organism concentrates upon that of the later books in the *Essay*. If Locke's *Essay* is to be interpreted as a consistent scheme of thought, undoubtedly Hume is right; but such an interpretation offers violence to Locke's contribution to philosophy.

SECTION III

In the philosophy of organism it is assumed that an actual entity is composite. 'Actuality' is the fundamental exemplification of composition; all other meanings of 'composition' are referent to this root-meaning. But 'actuality' is a general term, which merely indicates this ultimate type of composite unity: there are many composite unities to which this general term applies. There is no general fact of composition not expressible in terms of the composite constitutions of the individual occasions. Every proposition is entertained in the constitution of some one actual entity, or severally in the constitutions of many actual entities. This is only another rendering of the 'ontological principle.' It follows from the ontological principle, thus interpreted, that the notion of a 'common world' must find its exemplification in the constitution of each actual entity, taken by itself for analysis. For an actual entity cannot be a member of a 'common world,' except in the sense that the 'common world' is a constituent of its own constitution. It follows that every item of the universe, including all the other actual entities, are constituents in the constitution of any one actual entity. This conclusion has already been employed under the title of the 'principle of relativity.' This principle of relativity is the axiom by which the ontological principle is rescued

* Cf. *Essay*, II, XIV, 1.

from issuing in an extreme monism. Hume adumbrates this principle in his notion of 'repetition.'

Some principle is now required to rescue actual entities from being undifferentiated repetitions, each of the other, with mere numerical diversity. This requisite is supplied by the 'principle of intensive relevance.' The notion of intensive relevance is fundamental for the meaning of such concepts as 'alternative possibilities,' 'more or less,' 'important or negligible.' The principle asserts that any item of the universe, however preposterous as an abstract thought, or however remote as an actual entity, has its own gradation of relevance, as prehended, in the constitution of any one actual entity: it might have had more relevance; and it might have had less relevance, including the zero of relevance involved in the negative prehension; but in fact it has just *that* relevance whereby it finds its status in the constitution of *that* actual entity. It will be remembered that Hume finds it necessary to introduce the notion of variations in 'force and vivacity.' He is here making a particular application—and, as I believe, an unsuccessful application—of the general principle of intensive relevance.

There is interconnection between the degrees of relevance of different items in the same actual entity. This fact of interconnection is asserted in the 'principle of compatibility and contrariety.' There are items which, in certain respective gradations of relevance, are contraries to each other; so that those items, with their respective intensities of relevance, cannot coexist in the constitution of one actual entity. If some group of items, with their variety of relevance, can coexist in one actual entity, then the group, as thus variously relevant, is a compatible group. The various specific essences of one genus, whereby an actual entity may belong to one or other of the species but cannot belong to more than one, illustrate the incompatibility between two groups of items. Also in so far as a specific essence is complex, the specific essence is necessarily composed of compatible items, if there has been any exemplification of that species. But 'feelings' are the entities which are primarily 'compatible' or 'incompatible.' All other usages of these terms are derivative.

The words 'real' and 'potential' are, in this exposition, taken in senses which are antithetical. In their primary senses, they qualify the 'eternal objects.' These eternal objects determine *how* the world of actual entities enters into the constitution of each one of its

members via its feelings. And they also express *how* the constitution of any one actual entity is analysable into phases, related as presupposed and presupposing. Eternal objects express *how* the predecessor phase is absorbed into the successor phase without limitation of itself, but with additions necessary for the determination of an actual unity in the form of individual satisfaction. The *actual entities* enter into each others' constitutions under *limitations* imposed by incompatibilities * of feelings. Such incompatibilities relegate various elements in the constitutions of felt objects to the intensive zero, which is termed 'irrelevance.' The *preceding phases* enter into their successors with *additions* which eliminate the indeterminations. The *how* of the limitations, and the *how* of the additions, are alike the *realization* of eternal objects in the constitution of the actual entity in question. An eternal object in abstraction from any one particular actual entity is a potentiality for ingression into actual entities. In its ingression into any one actual entity, either as relevant or as irrelevant, it retains its potentiality of indefinite diversity of modes of ingression, a potential indetermination rendered determinate in this instance. The definite ingression into a particular actual entity is not to be conceived as the sheer evocation of that eternal object from 'not-being' into 'being'; it is the evocation of determination out of indetermination. Potentiality becomes reality; and yet retains its message of alternatives which the actual entity has avoided. In the constitution of an actual entity:—whatever component is red, might have been green; and whatever component is loved, might have been coldly esteemed. The term 'universal' is unfortunate in its application to eternal objects; for it seems to deny, and in fact it was meant to deny, that the actual entities also fall within the scope of the principle of relativity. If the term 'eternal objects' is disliked, the term 'potentials' would be suitable. The eternal objects are the pure potentials of the universe; and the actual entities differ from each other in their realization of potentials. Locke's term 'idea,' in his primary use of it in the first two books of the *Essay,* means the determinate ingression of an eternal object into the actual entity in question. But he also introduces the limitation to conscious mentality, which is here abandoned.

* Dr. H. M. Sheffer has pointed out the fundamental logical importance of the notion of 'incompatibility'; cf. *Transl. Amer. Math. Soc.,* Vol. XIV, pp. 481–488; and Introduction to Vol. I of *Principia Mathematica* (2nd edition).

Thus in the philosophy of organism, Locke's first use of the term 'idea' is covered by the doctrine of the 'ingression' of eternal objects into actual entities; and his second use of the same term is covered by the doctrine of the 'objectification' of actual entities. The two doctrines cannot be explained apart from each other: they constitute explanations of the two fundamental principles—the ontological principle and the principle of relativity.

The four stages constitutive of an actual entity have been stated above in Part II, Chapter III, Section I. They can be named, datum, process, satisfaction, decision. The two terminal stages have to do with 'becoming' in the sense of the transition from the settled actual world to the new actual entity relatively to which that settlement is defined. But such 'definition' must be found as an element in the actual entities concerned. The 'settlement' which an actual entity 'finds' is its datum. It is to be conceived as a limited perspective of the 'settled' world provided by the eternal objects concerned. This datum is 'decided' by the settled world. It is 'prehended' by the new superseding entity. The datum is the objective content of the experience. The decision, providing the datum, is a transference of self-limited appetition; the settled world provides the 'real potentiality' that its many actualities be felt compatibly; and the new concrescence starts from this datum. The perspective is provided by the elimination of incompatibilities. The final stage, the 'decision,' is how the actual entity, having attained its individual 'satisfaction,' thereby adds a determinate condition to the settlement for the future beyond itself. Thus the 'datum' is the 'decision received,' and the 'decision' is the 'decision transmitted.' Between these two decisions, received and transmitted, there lie the two stages, 'process' and 'satisfaction.' The datum is indeterminate as regards the final satisfaction. The 'process' is the addition of those elements of feeling whereby these indeterminations are dissolved into determinate linkages attaining the actual unity of an individual actual entity. The actual entity, in becoming itself, also solves the question as to *what* it is to be. Thus process is the stage in which the creative idea works towards the definition and attainment of a determinate individuality. Process is the growth and attainment of a final end. The progressive definition of the final end is the efficacious condition for its attainment. The determinate unity of an actual entity is bound together by the final causation towards an ideal progressively defined by its progressive relation to the deter-

minations and indeterminations of the datum. The ideal, itself felt, defines what 'self' shall arise from the datum; and the ideal is also an element in the self which thus arises.

According to this account, efficient causation expresses the transition from actual entity to actual entity; and final causation expresses the internal process whereby the actual entity becomes itself. There is the becoming of the datum, which is to be found in the past of the world; and there is the becoming of the immediate self from the datum. This latter becoming is the immediate actual process. An actual entity is at once the product of the efficient past, and is also, in Spinoza's phrase, *causa sui*. Every philosophy recognizes, in some form or other, this factor of self-causation, in what it takes to be ultimate actual fact. Spinoza's words have already been quoted. Descartes' argument, from the very fact of thinking, assumes that this freely determined operation is thereby constitutive of an occasion in the endurance of an actual entity. He writes (*Meditation II*): 'I am, I exist, is necessarily true each time that I pronounce it, or that I mentally conceive it.' Descartes in his own philosophy conceives the thinker as creating the occasional thought. The philosophy of organism inverts the order, and conceives the thought as a constituent operation in the creation of the occasional thinker. The thinker is the final end whereby there is the thought. In this inversion we have the final contrast between a philosophy of substance and a philosophy of organism. The operations of an organism are directed towards the organism as a 'superject,' and are not directed from the organism as a 'subject.' The operations are directed *from* antecedent organisms and *to* the immediate organism. They are 'vectors,' in that they convey the many things into the constitution of the single superject. The creative process is rhythmic: it swings from the publicity of many things to the individual privacy; and it swings back from the private individual to the publicity of the objectified individual. The former swing is dominated by the final cause, which is the ideal; and the latter swing is dominated by the efficient cause which is actual.

SECTION IV

From the point of view of the philosophy of organism, the credit must be given to Hume that he emphasized the 'process' inherent in the fact of being a mind. His analysis of that process is faulty in its

details. It was bound to be so; because, with Locke, he misconceived his problem to be the analysis of mental operations. He should have conceived it as the analysis of operations constituent of actual entities. He would then have found mental operations in their proper place. Kant followed Hume in this misconception; and was thus led to balance the world upon thought—oblivious to the scanty supply of thinking. But Hume, Kant, and the philosophy of organism agree that the task of the critical reason is the analysis of constructs; and 'construction' is 'process.' Hume's analysis of the construct which constitutes a mental occasion is: impressions of sensation, ideas of impressions of sensation, impressions of reflection, ideas of impressions of reflection. This analysis may be found obscurely in Locke. But Hume exhibits it as an orderly process; and then endeavours—and fails—to express in terms of it our ordinary beliefs, in which he shares.

For subsequent empiricists the pleasure of the dogma has overcome the metaphysical rule of evidence: that we must bow to those presumptions, which, in despite of criticism, we still employ for the regulation of our lives. Such presumptions are imperative in experience. Rationalism is the search for the coherence of such presumptions. Hume, in his series of ideas and of impressions derivate from impressions of sensation, implicitly allows that the building-up of experience is a process of addition to original data. The philosophy of organism, in this respect, agrees with Hume. It disagrees with Hume as to the proper characterization of the primary data. In Hume's philosophy the primary impressions are characterized in terms of universals, e.g. in the first section of his *Treatise* he refers to the colour 'red' as an illustration. This is also the doctrine of the first two books of Locke's *Essay*. But in Locke's third book a different doctrine appears, and the primary data are explicitly said to be 'ideas of particular existents.' According to Locke's second doctrine, the ideas of universals are derived from these primary data by a process of comparison and analysis. The philosophy of organism agrees in principle with this second doctrine of Locke's. It is difficult, and trifling, to determine the exact extent of the agreement; because the expositions of Locke and Hume bring in the very derivative operations involving consciousness. The organic philosophy does not hold that the 'particular existents' are prehended apart from universals; on the contrary, it holds that they are prehended by the mediation of universals.

In other words, each actuality is prehended by means of some element of its own definiteness. This is the doctrine of the 'objectification' of actual entities. Thus the primary stage in the concrescence of an actual entity is the way in which the antecedent universe enters into the constitution of the entity in question, so as to constitute the basis of its nascent individuality. A converse way of looking at this truth is that the relevance to other actual entities of its own status in the actual world, is the initial datum in the process of its concrescence. When it is desired to emphasize this interpretation of the datum, the phrase 'objective content' will be used synonymously with the term 'datum.' Of course, strictly speaking, the universals, to which Hume confines the datum, are also 'objects'; but the phrase 'objective content' is meant to emphasize the doctrine of 'objectification' of actual entities. If experience be not based upon an objective content, there can be no escape from a solipsist subjectivism. But Hume, and Locke in his main doctrine, fail to provide experience with any objective content. Kant, for whom 'process' is mainly a process of thought, accepts Hume's doctrine as to the 'datum' and turns the 'apparent' objective content into the end of the construct. So far, Kant's 'apparent' objective content seems to take the place of the 'satisfaction' in the philosophy of organism. In this way there can be no real escape from the solipsist difficulty. But Kant in his appeal to 'practical reason' admits also the 'satisfaction' in a sense analogous to that in the philosophy of organism; and by an analysis of its complex character he arrives at ultimate actualities which, according to his account, cannot be discovered by any analysis of 'mere appearance.' This is a very complex doctrine, which has been reproduced in all philosophies derivative from Kant. The doctrine gives each actual entity two worlds, one world of mere appearance, and the other world compact of ultimate substantial fact. On this point, as to the absence of 'objective content' in the datum for experience, Santayana * seems to agree with Hume and Kant. But if his introduction of 'animal faith' is to be taken as a re-examination of the datum under the influence of the sceptical conclusion from Hume's doctrine, then he, as his second doctrine, is practically reasserting Locke's second doctrine. But if he is appealing to 'practice' away from the critical examination of our sources of information, he must be

* Cf. *Scepticism and Animal Faith.*

classed with Hume and Kant, although differing from them in every detail of procedure.

In view of the anti-rationalism of Hume's contented appeal to 'practice,' it is very difficult to understand—except as another example of anti-rationalism—the strong objection, entertained by Hume and by his 'empiricist' followers, to the anti-rationalistic basis of some forms of religious faith. This strain of anti-rationalism which Locke and Hume explicitly introduced into philosophy marks the final triumph of the anti-rationalistic reaction against the rationalism of the Middle Ages. Rationalism is the belief that clarity can only be reached by pushing explanation to its utmost limits. Locke, who hoped to attain final clarity in his analysis of human understanding in divorce from metaphysics, was, so far, an anti-rationalist. But Hume, in so far as he is to be construed as remaining content with two uncoordinated sets of beliefs, one based on the critical examination of our sources of knowledge, and the other on the critical examination of beliefs involved in 'practice,' reaches the high watermark of anti-rationalism in philosophy; for 'explanation' is the analysis of coordination.

SECTION V

The process whereby an actual entity, starting from its objective content, attains its individual satisfaction, will be more particularly analysed in Part III.* The primary character of this process is that it is individual to the actual entity; it expresses how the datum, which involves the actual world, becomes a component in the one actual entity. There must therefore be no further reference to other actual entities; the elements available for the explanation are simply: the objective content, eternal objects, and the selective concrescence of feelings whereby an actual entity becomes itself. It must be remembered that the objective content is analysable into actual entities under limited perspectives provided by their own natures; these limited perspectives involve eternal objects in grades of relevance. If the 'process' were primarily a process of understanding, we should have to note that 'grades of relevance' are only other eternal objects in grades of relevance, and so on indefinitely. But we have not the sort of understandings which embrace such indefinite progressions. Accordingly there is here a vicious regress, if the process be essentially

* *Process and Reality.*

a process of understanding. But this is not the primary description of it; the process is a process of 'feeling.' In feeling, what is felt is not necessarily analysed; in understanding, what is understood is analysed, in so far as it is understood. Understanding is a special form of feeling. Thus there is no vicious regress in feeling, by reason of the indefinite complexity of what is felt. Kant, in his Transcendental Aesthetic, emphasizes the doctrine that in intuition a complex datum is intuited as one.

Again the selection involved in the phrase 'selective concrescence' is not a selection among the components of the objective content; for, by hypothesis, the objective content is a datum. The compatibilities and incompatibilities which impose the perspective, transforming the actual world into the datum, are inherent in the nature of things. Thus the selection is a selection of relevant eternal objects whereby what is a datum from without is transformed into its complete determination as a fact within. The problem which the concrescence solves is, how the many components of the objective content are to be unified in one felt content with its complex subjective form. This one felt content is the 'satisfaction,' whereby the actual entity is its particular individual self; to use Descartes' phrase, 'requiring nothing but itself in order to exist.' In the conception of the actual entity in its phase of satisfaction, the entity has attained its individual separation from other things; it has absorbed the datum, and it has not yet lost itself in the swing back to the 'decision' whereby its appetition becomes an element in the data of other entities superseding it. Time has stood still—if only it could.

Thus process is the admission of eternal objects in their new rôle of investing the datum with the individuality of the subject. The datum, qua mere datum, includes the many individualities of the actual world. The satisfaction includes these many individualities as subordinate contributors to the one individuality. The process admits or rejects, eternal objects which by their absorption into the subjective forms of the many feelings effect this integration. The attainment of satisfaction relegates all eternal objects which are not 'felt' either as determinants of definiteness in the data or as determinants of definiteness in the subjective form of the satisfaction, into the status of contraries to the eternal objects which are thus felt. Thus all indeterminations respecting the potentialities of the universe are

definitely solved so far as concerns the satisfaction of the subject in question.

The process can be analysed genetically into a series of subordinate phases which presuppose their antecedents. Neither the intermediate phases, nor the datum which is the primary phase of all, determine the final phase of determinate individualization. Thus an actual entity, on its subjective side, is nothing else than what the universe is for it, including its own reactions. The reactions are the subjective forms of the feelings, elaborated into definiteness through stages of process. An actual entity achieves its own unity by its determinate feelings respecting every item of the datum. Every individual objectification in the datum has its perspective defined by its own eternal objects with their own relevance compatible with the relevance of other objectifications. Each such objectification, and each such complex of objectifications, in the datum is met with a correspondent feeling, with its determinate subjective form, until the many become one experience, the satisfaction. The philosophies of substance presuppose a subject which then encounters a datum, and then reacts to the datum. The philosophy of organism presupposes a datum which is met with feelings, and progressively attains the unity of a subject. But with this doctrine, 'superject' would be a better term than 'subject.' Locke's 'ideas of reflection' are the feelings, in so far as they have entered into consciousness.

It is by reference to feelings that the notion of 'immediacy' obtains its meaning. The mere objectification of actual entities by eternal objects lacks 'immediacy.' It is 'repetition'; and this is a contrary to 'immediacy.' But 'process' is the rush of feelings whereby second-handedness attains subjective immediacy; in this way, subjective form overwhelms repetition, and transforms it into immediately felt satisfaction; objectivity is absorbed into subjectivity. It is useful to compare this analysis of the construction of an act of experience with Kant's. In the first place Kant's act of experience is essentially knowledge. Thus whatever is not knowledge is necessarily inchoate, and merely on its way to knowledge. In comparing Kant's procedure with that of the philosophy of organism, it must be remembered that an 'apparent' objective content is the end of Kant's process, and thus takes the place of 'satisfaction' in the process as analysed in the philosophy of organism. In Kant's phraseology at the beginning of the *Critique of Pure Reason,* this 'apparent' objective content is referred

to as 'objects.' He also accepts Hume's sensationalist account of the datum. Kant places this sentence at the commencement of the *Critique:* 'Objects therefore are given to us through our sensibility. Sensibility alone supplies us with intuitions. These intuitions become thought through the understanding, and hence arise conceptions.' * This is expanded later in a form which makes Kant's adhesion to Hume's doctrine of the datum more explicit: 'And here we see that the impressions of the senses give the first impulse to the whole faculty of knowledge with respect to them, and thus produce experience which consists of two very heterogeneous elements, namely, matter for knowledge, derived from the senses (*eine Matiere zur Erkenntniss aus den Sinnen*) and a certain form according to which it is arranged, derived from the internal source of pure intuition and pure thought, first brought into action by the former, and then producing concepts.' † Also: 'Thoughts without content are empty, intuitions without concepts are blind.' †† In this last statement the philosophy of organism is in agreement with Kant; but for a different reason. It is agreed that the functioning of concepts is an essential factor in knowledge, so that 'intuitions without concepts are blind.' But for Kant, apart from concepts there is nothing to know; since objects related in a knowable world are the product of conceptual functioning whereby categoreal form is introduced into the sense-datum, which otherwise is intuited in the form of a mere spatio-temporal flux of sensations. Knowledge requires that this mere flux be particularized by conceptual functioning, whereby the flux is understood as a nexus of 'objects.' Thus for Kant the process whereby there is experience is a process from subjectivity to apparent objectivity. The philosophy of organism inverts this analysis, and explains the process as proceeding from objectivity to subjectivity, namely, from the objectivity, whereby the external world is a datum, to the subjectivity, whereby there is one individual experience. Thus, according to the philosophy of organism, in every act of experience there are objects for knowledge; but, apart from the inclusion of intellectual functioning in that act of experience, there is no knowledge.

We have now come to Kant, the great philosopher who first, fully

* 'Vermittelst der Sinnlichkeit also werden uns Gegenstände gegeben, und sie allein liefert uns Anschauungen; durch den Verstand aber werden sie gedacht, und von ihm entspringen Begriffe.' Translation in the text is Max Müller's.

† Cf. *Transcendental Analytic,* Ch. II, Sec. I (Max Müller).

†† Cf. *Transcendental Logic,* Introduction, Sec. I.

and explicitly, introduced into philosophy the conception of an act of experience as a constructive functioning, transforming subjectivity into objectivity, or objectivity into subjectivity; the order is immaterial in comparison with the general idea. We find the first beginnings of the notion in Locke and in Hume. Indeed, in Locke, the process is conceived in its correct order, at least in the view of the philosophy of organism. But the whole notion is only vaguely and inadequately conceived. The full sweep of the notion is due to Kant. The second half of the modern period of philosophical thought is to be dated from Hume and Kant. In it the development of cosmology has been hampered by the stress laid upon one, or other, of three misconceptions:

(i) The substance-quality doctrine of actuality.

(ii) The sensationalist doctrine of perception.

(iii) The Kantian doctrine of the objective world as a construct from subjective experience.

The combined influence of these allied errors has been to reduce philosophy to a negligible influence in the formation of contemporary modes of thought. Hume himself introduces the ominous appeal to 'practice'—not in criticism of his premises, but in supplement to his conclusions. Bradley, who repudiates Hume, finds the objective world in which we live, and move, and have our being, 'inconsistent if taken as real.' Neither side conciliates philosophical conceptions of a real world with the world of daily experience.

Adventures of Ideas

Part I Sociological

Chapter VI Foresight 751
Epilogue to Part I 763

Part II Cosmological

Chapter VII Laws of Nature 763

Chapter VIII Cosmologies 779

Part III Philosophical

Chapter XI Objects and Subjects 798

Chapter XII Past, Present, Future 813

Chapter XIII The Grouping of Occasions 822

Chapter XIV Appearance and Reality 829

Chapter XV Philosophic Method 840

ADVENTURES OF IDEAS

Adventures of Ideas, published in 1933, is a work in four parts which develops many ideas sketched out in some of the preceding books. The first part, "Sociological," traces the development of the idea "freedom" as a factor in Western civilization. The last chapter of this part, "Foresight," is included here. It was originally an address delivered at the Harvard Graduate School of Business Administration.

Part II, "Cosmological," is represented here by its first two chapters, "Laws of Nature," and "Cosmologies," in which Whitehead develops various different modes of interpreting laws of nature, and explains in detail his own philosophical theory of the status of these laws.

Part III, "Philosophical," carries on the discussion of some central philosophical notions which were dealt with in Process and Reality. This entire part is included in this anthology. The first chapter, "Objects and Subjects," was Whitehead's presidential address to the Eastern Division of the American Philosophical Association, and is largely concerned with the problem of perception.

Part IV, "Civilization," which is not included in this anthology, consists of five chapters on "Truth," "Beauty," "Truth and Beauty," "Adventure," and "Peace."

It is reported that whenever Whitehead was asked to name that one of his many books which was personally most satisfactory to him, he would hesitate between Adventures of Ideas and Science and the Modern World. Between the two came the systematic elaboration of Process and Reality; and, although Adventures of Ideas is written in the same general style as Science and the Modern World, it clearly owes much of its strength to the fact that Whitehead had so recently undertaken such a fully developed exposition of his cosmology.

Part I Sociological

CHAPTER VI *FORESIGHT*

SECTION I. By the phrase Historical Foresight, I mean something quite different from the accurate exercise of Scientific Induction. Science is concerned with generalities. The generalities apply, but they do not determine the course of history apart from some anchorage in fact. There might have been many alternative courses of history conditioned by the same laws. Perhaps, if we knew enough of the laws, then we should understand that the development of the future from the past is completely determined by the details of the past and by these scientific laws which condition all generation. Unfortunately our knowledge of scientific laws is woefully defective, and our knowledge of the relevant facts of the present and the past is scanty in the extreme. Thus as the result of all our science, we are ignorant of that remote epoch when there will be a second collision between the sun and a passing star, we are ignorant of the future of life on the earth, we are ignorant of the future of mankind, we are ignorant of the course of history a year hence, we are ignorant of most of the domestic details of our lives tomorrow, we are even ignorant of the term that has been set to our own existence.

This catalogue of ignorances at once reminds us that our state is not that of blank absence of knowledge. Our ignorance is suffused with Foresight. Also the basis of our defect in foresight is our scant knowledge of the relevant detailed facts in past and present which are required for the application of the scientific laws. Where the circumstances are comparatively simple, as in Astronomy, we know that the facts and the astronomical laws provide an apparatus of great accuracy in forecast. The main difficulty in Historical Foresight is the power of collecting and selecting the facts relevant to the particular type of forecast which we wish to make. Discussions on the method of science wander off onto the topic of experiment. But experiment is nothing else than a mode of cooking the facts for the sake of exemplifying the law. Unfortunately the facts of history,

even those of private individual history, are on too large a scale. They surge forward beyond control.

It is thus evident that this topic of Historical Foresight is not to be exhausted by a neat description of some definite methods. It is faced with two sources of difficulty, where science has only one. Science seeks the laws only, but Foresight requires in addition due emphasis on the relevant facts from which the future is to emerge. Of the two tasks required for Foresight, this selection amid the welter is the more difficult. Probably a neat doctrine of Foresight is impossible. But what can be done is to confine attention to one field of human activity, and to describe the type of mentality which seems requisite for the attainment of Foresight within that field. The present state of the world, and the course of the discussions in this book, suggest the field of Commercial relations. This field will therefore be chosen to illustrate the function of ideas in the provision of anticipation and purpose.

To avoid misunderstanding I must disclaim the foolish notion that it is possible for anyone, devoid of personal experience of commerce, to provide useful suggestions for its detailed conduct. There is no substitute for first-hand practice. Also the word 'commerce' is here used in the largest sense of that term, in which it includes a variety of activities. Any useful theory, capable of immediate application to specific instances, must depend on a direct knowledge of the relevant reactions of men and women composing that society, or perhaps group of nations, within which the specific business in question is to flourish. In this discussion there is no pretence of such detailed knowledge.

There remains, however, the question of the general type of mentality which in the present condition of the world will promote the general success of a commercial community. Such a type is, of course, very complex. But we are considering one unquestioned element in it, namely Foresight, and will discuss the conditions for its development and its successful exercise.

Some people are born with astounding knacks of the mind. For example, there are calculating boys who can perform intricate operations of mental arithmetic in a flash, there are also other sorts of peculiar faculties of divination; in particular there are men with a knack of shrewdness in judging circumstances within the narrow range of their immediate observation. But after all, bankers prefer

that their clerks should learn arithmetic, and trained geologists are preferred to men with divining rods. In the same way, there are general conditions of training which promote the development of a wider type of foresight.

It is a great mistake to divide people into sharp classes, namely, people with such-and-such a knack and people without it. These trenchant divisions are simply foolish. Most humans are born with certain aptitudes. But these aptitudes can easily remain latent unless they are elicited into activity by fortunate circumstances. If anyone has no aptitude of a certain type, no training can elicit it. But, granted the aptitude, we can discuss the ways of training it. Foresight depends upon understanding. In practical affairs it is a habit. But the habit of foreseeing is elicited by the habit of understanding. To a large extent, understanding can be acquired by a conscious effort and it can be taught. Thus the training of Foresight is by the medium of Understanding. Foresight is the product of Insight.

Section II. The general topic to be understood is the entire internal functioning of human society, including its technologies, the biological and physical laws on which these technologies depend, and including the sociological reactions of humans depending on fundamental psychological principles. In fact, the general topic is sociology in the broadest sense of the term, including its auxiliary sciences. Such a width of understanding is, of course, beyond the grasp of any single human. But no part of it is entirely foreign to the provision of foresight in business. Such a complete understanding is a coöperative enterprise; and a business community maintains its success for long periods so far as its average foresight is dominated by some approach to such general understanding.

We shall comprehend better the varieties of individual understanding which go to complete this general equipment of an ideal business community, if we commence by considering the contrast between understanding and routine.

Routine is the god of every social system; it is the seventh heaven of business, the essential component in the success of every factory, the ideal of every statesman. The social machine should run like clockwork. Every crime should be followed by an arrest, every arrest by a judicial trial, every trial by a conviction, every conviction by a punishment, every punishment by a reformed character. Or, you can conceive an analogous routine concerning the making of a motor

car, starting with the iron in the ore, and the coal in the mine, and ending with the car driving out of the factory and with the president of the corporation signing the dividend warrants, and renewing his contracts with the mining corporations. In such a routine everyone from the humblest miner to the august president is exactly trained for his special job. Every action of miner or president is the product of conditioned reflexes, according to current physiological phraseology. When the routine is perfect, understanding can be eliminated, except such minor flashes of intelligence as are required to deal with familiar accidents, such as a flooded mine, a prolonged drought, or an epidemic of influenza. A system will be the product of intelligence. But when the adequate routine is established, intelligence vanishes, and the system is maintained by a coördination of conditioned reflexes. What is then required from the humans is receptivity of special training. No one, from president to miner, need understand the system as a whole. There will be no foresight, but there will be complete success in the maintenance of the routine.

Now it is the beginning of wisdom to understand that social life is founded upon routine. Unless society is permeated, through and through, with routine, civilization vanishes. So many sociological doctrines, the products of acute intellects, are wrecked by obliviousness to this fundamental sociological truth. Society requires stability, foresight itself presupposes stability, and stability is the product of routine. But there are limits to routine, and it is for the discernment of these limits, and for the provision of the consequent action, that foresight is required.

The two extremes of complete understanding and of complete routine are never realized in human society. But of the two, routine is more fundamental than understanding, that is to say, routine modified by minor flashes of short range intelligence. Indeed the notion of complete understanding controlling action is an ideal in the clouds, grotesquely at variance with practical life. But we have under our eyes countless examples of societies entirely dominated by routine. The elaborate social organizations of insects appear to be thoroughgoing examples of routine. Such organizations achieve far-reaching, complex purposes: they involve a differentiation of classes, from cows to serfs, from serfs to workers, from workers to warriors, from warriors to janitors, and from janitors to queens. Such organizations have regard to needs in a distant future, especially if the compara-

tively short space of life of the individual insects is taken into account as the unit of measurement.

These insect societies have been astoundingly successful, so far as concerns survival power. They seem to have a past extending over tens of thousands of years, perhaps of millions of years. It is the greatest of mistakes to believe that it has required the high-grade intelligence of mankind to construct an elaborate social organization. A particular instance of this error is the prevalent assumption that any social routine whose purposes are not obvious to our analysis is thereby to be condemned as foolish. We can observe insects performing elaborate routine actions whose purposes they cannot possibly understand, which yet are essential either for their own individual survival or for race-survival.

But these insect societies have one great characteristic in common. They are not progressive. It is exactly this characteristic that discriminates communities of mankind from communities of insects. Further, this great fact of progressiveness, be it from worse to better, or from better to worse, has become of greater and greater importance in Western civilization as we come to modern times. The rate of change has increased even in my life-time. It is possible that in future ages mankind may relapse into the stage of stable societies. But such a relapse is extremely unlikely within any span of time which we need take into account.

Section III. The recent shortening of the time-span between notable changes in social customs is very obvious, if we examine history. Originally it depended upon some slow development of physical causes. For example, a gradual change of physical configuration such as the elevation of mountains: the time-span for such a change is of the order of a million years. Again, a gradual change of climate: the time-span for such a change is of the order of five thousand years. Again a gradual over-population of the region occupied by some community with its consequent swarming into new territories: having regard to the huge death-rate of pre-scientific ages, the time-span of such a change was of the order of five hundred years. Again, the sporadic inventions of new technologies, such as the chipping of flints, the invention of fire, the taming of animals, the invention of metallurgy: in the pre-scientific ages, the average time-span for such changes was, at least, of the order of five hundred years. If we compare the technologies of civilizations west of Meso-

potamia at the epochs 100 A.D., the culmination of the Roman Empire, and 1400 A.D., the close of the Middle Ages, we find practically no advance in technology. There was some gain in metallurgy, some elaboration of clockwork, the recent invention of gunpowder with its influence all in the future, some advance in the art of navigation, also with its influence in the future. If we compare 1400 A.D. with 1700 A.D., there is a great advance; gunpowder, and printing, and navigation, and the technique of commerce, had produced their effect. But even then, the analogy between life in the eighteenth century and life in the great period of ancient Rome was singularly close, so that the peculiar relevance of Latin literature was felt vividly. In the fifty years between 1780 and 1830, a number of inventions came with a rush into effective operation. The age of steam power and of machinery was introduced. But for two generations, from 1830 to 1890, there was a singular uniformity in the principles of technology which were regulating the structure of society and the usages of business.

The conclusion to be drawn from this survey is a momentous one. Our sociological theories, our political philosophy, our practical maxims of business, our political economy, and our doctrines of education, are derived from an unbroken tradition of great thinkers and of practical examples, from the age of Plato in the fifth century before Christ to the end of the last century. The whole of this tradition is warped by the vicious assumption that each generation will substantially live amid the conditions governing the lives of its fathers and will transmit those conditions to mould with equal force the lives of its children. We are living in the first period of human history for which this assumption is false.

Of course in the past, there were great catastrophes, for example, plagues, floods, barbarian invasions. But, if such catastrophes were warded off, there was a stable, well-known condition of civilized life. This assumption subtly pervades the premises of political economy, and has permitted it to confine attention to a simplified edition of human nature. It is at the basis of our conception of the reliable business man, who has mastered a technique and never looks beyond his contracted horizon. It colours our political philosophy and our educational theory, with their overwhelming emphasis on past experience. The note of recurrence dominates the wisdom of the past, and still persists in many forms even where explicitly the fallacy

of its modern application is admitted. The point is that in the past the time-span of important change was considerably longer than that of a single human life. Thus mankind was trained to adapt itself to fixed conditions.

Today this time-span is considerably shorter than that of human life, and accordingly our training must prepare individuals to face a novelty of conditions. But there can be no preparation for the unknown. It is at this point that we recur to the immediate topic, Foresight. We require such an understanding of the present conditions, as may give us some grasp of the novelty which is about to produce a measurable influence on the immediate future. Yet the doctrine, that routine is dominant in any society that is not collapsing, must never be lost sight of. Thus the grounds, in human nature and in the successful satisfaction of purpose, these grounds for the current routine must be understood; and at the same time the sorts of novelty just entering into social effectiveness have got to be weighed against the old routine. In this way the type of modification and the type of persistence exhibited in the immediate future may be foreseen.

SECTION IV. It is now time to give some illustrations of assertions already made. Consider our main conclusions that our traditional doctrines of sociology, of political philosophy, of the practical conduct of large business, and of political economy are largely warped and vitiated by the implicit assumption of a stable unchanging social system. With this assumption it is comparatively safe to base reasoning upon a simplified edition of human nature. For well-known stimuli working under well-known conditions produce well-known reactions. It is safe then to assume that human nature, for the purpose in hand, is adequately described in terms of some of the major reactions to some of the major stimuli. For example, we can all remember our old friend, the economic man.

The beauty of the economic man was that we knew exactly what he was after. Whatever his wants were, he knew them and his neighbours knew them. His wants were those developed in a well-defined social system. His father and grandfather had the same wants, and satisfied them in the same way. So whenever there was a shortage, everyone—including the economic man himself—knew what was short, and knew the way to satisfy the consumer. In fact, the consumer knew what he wanted to consume. This was the demand. The producer knew how to produce the required articles, hence the

supply. The men who got the goods onto the spot first, at the cheapest price, made their fortunes; the other producers were eliminated. This was healthy competition. This is beautifully simple and with proper elaboration is obviously true. It expresses the dominant truth exactly so far as there are stable well-tried conditions. But when we are concerned with a social system which in important ways is changing, this simplified conception of human relations requires severe qualification.

It is, of course, common knowledge that the whole trend of political economy during the last thirty or forty years has been away from these artificial simplifications. Such sharp-cut notions as 'the economic man,' 'supply and demand,' 'competition,' are now in process of dilution by a close study of the actual re-actions of various populations to the stimuli which are relevant to modern commerce. This exactly illustrates the main thesis. The older political economy reigned supreme for about a hundred years from the time of Adam Smith, because in its main assumptions it did apply to the general circumstances of life as led, then and for innumerable centuries in the past. These circumstances were then already passing away. But it still remained a dominant truth that in commercial relations men were dominated by well-conditioned reactions to completely familiar stimuli.

In the present age, the element of novelty which life affords is too prominent to be omitted from our calculations. A deeper knowledge of the varieties of human nature is required to determine the reaction, in its character and its strength, to those elements of novelty which each decade of years introduces into social life. The possibility of this deeper knowledge constitutes the Foresight under discussion.

Another example which concerns sociological habits, and thence business relations and the shifting values of property, is to be seen in the history of cities. Throughout the whole span of civilization up to the present moment, the growth of condensed aggregates of humans, which we call cities, has been an inseparable accompaniment of the growth of civilization. There are many obvious reasons, the defence of accumulated wealth behind city walls, the concentration of materials requisite for manufacture, the concentration of power in the form of human muscles and, later, in the form of available heat energy, the ease of mutual intercourse required for business relations, the pleasure arising from a concentration of æsthetic and

cultural opportunities, the advantages of a concentration of governmental and other directing agencies, administrative, legal, and military.

But there are disadvantages in cities. As yet no civilization has been self-supporting. Each civilization is born, it culminates, and it decays. There is a widespread testimony that this ominous fact is due to inherent biological defects in the crowded life of cities. Now, slowly and at first faintly, an opposite tendency is showing itself. Better roads and better vehicles at first induced the wealthier classes to live on the outskirts of the cities. The urgent need for defence had also vanished. This tendency is now spreading rapidly downwards. But a new set of conditions is just showing itself. Up to the present time, throughout the eighteenth and nineteenth centuries, this new tendency placed the homes in the immediate suburbs, but concentrated manufacturing activity, business relations, government, and pleasure, in the centres of the cities. Apart from the care of children, and periods of sheer rest, the active lives were spent in the cities. In some ways, the concentration of such activities was even more emphasized, and the homes were pushed outwards even at the cost of the discomfort of commuting. But, if we examine the trend of technology during the past generation, the reasons for this concentration are largely disappearing. Still more, the reasons for the choice of sites for cities are also altering. Mechanical power can be transmitted for hundreds of miles, men can communicate almost instantaneously by telephone, the chiefs of great organizations can be transported by airplanes, the cinemas can produce plays in every village, music, speeches, and sermons can be broadcast. Almost every reason for the growth of cities, concurrently with the growth of civilization, has been profoundly modified.

What then is to be the future of cities, three hundred years hence, a hundred years hence, or even thirty years hence? I do not know. But I venture a guess:—that those who are reasonably fortunate in this foresight will make their fortunes, and that others will be ruined by mistakes in calculation.

My second point that the reasons for the choice of sites for cities have also been modified is illustrated by recent changes in my own country, England. The first effect of the new industrial age of the eighteenth and nineteenth centuries was to concentrate population round the coal-fields. Thus the central portion of England on its

northern edge has become one huge city, disguised under different names for its various regional parts. But the novel conditions are shifting population and manufactures to the south of England, near to the great southern ports which look towards the Mediterranean, the South Atlantic Ocean, and the Panama Canal. They are the best ports, with the easiest navigation, and with uncrowded land around them. At present the transmission of electric power is one of the major pre-occupations of the government of England.

The effect of new technologies on the sites of cities, and on transformations of cities, is one of the fundamental problems which must enter into all sociological theories, including the forecasting of business relations. We must not exaggerate the importance of these particular examples. They are just two examples selected from a whole situation which can be analysed into innumerable examples with the same moral. I mean nothing so absurd as that all industrialists should meditate on the future of cities. The topic may be quite irrelevant to the future activities of most of them. Also I am ignorant as to how much Political Economy they should study.

But we are faced with a fluid, shifting situation in the immediate future. Rigid maxims, a rule-of-thumb routine, and cast-iron particular doctrines will spell ruin. The business of the future must be controlled by a somewhat different type of men to that of previous centuries. The type is already changing, and has already changed so far as the leaders are concerned. The Business Schools of Universities are concerned with spreading this newer type throughout the nations by aiming at the production of the requisite mentality.

SECTION V. I will conclude this chapter by a sketch of the Business Mind of the future. In the first place it is fundamental that there be a power of conforming to routine, of supervising routine, of constructing routine, and of understanding routine both as to its internal structure and as to its external purposes. Such a power is the bedrock of all practical efficiency. But for the production of the requisite Foresight, something more is wanted. This extra endowment can only be described as a philosophic power of understanding the complex flux of the varieties of human societies: for instance, the habit of noting varieties of demands on life, of serious purposes, of frivolous amusements. Such instinctive grasp of the relevant features of social currents is of supreme importance. For example, the time-span of various types of social behaviour is of the essence of their

effect on policy. A widespread type of religious interest, with its consequent modes of behaviour, has a dominant life of about a hundred years, while a fashion of dress survives any time between three months and three years. Methods of agriculture change slowly. But the scientific world seems to be on the verge of far-reaching biological discoveries. The assumption of slow changes in agriculture must therefore be scanned vigilantly. This example of time-spans can be generalized. The quantitative aspect of social changes is of the essence of business relations. Thus the habit of transforming observation of qualitative changes into quantitative estimates should be a characteristic of business mentality.

I have said enough to show that the modern commercial mentality requires many elements of discipline, scientific and sociological. But the great fact remains that details of relevant knowledge cannot be foreseen. Thus even for mere success, and apart from any question of intrinsic quality of life, an unspecialized aptitude for eliciting generalizations from particulars and for seeing the divergent illustration of generalities in diverse circumstances is required. Such a reflective power is essentially a philosophic habit: it is the survey of society from the standpoint of generality. This habit of general thought, undaunted by novelty, is the gift of philosophy, in the widest sense of that term.

Section VI. But the motive of success is not enough. It produces a short-sighted world which destroys the sources of its own prosperity. The cycles of trade depression which afflict the world warn us that business relations are infected through and through with the disease of short-sighted motives. The robber barons did not conduce to the prosperity of Europe in the Middle Ages, though some of them died prosperously in their beds. Their example is a warning to our civilization. Also we must not fall into the fallacy of thinking of the business world in abstraction from the rest of the community. The business world is one main part of the very community which is the subject-matter of our study. The behaviour of the community is largely dominated by the business mind. A great society is a society in which its men of business think greatly of their functions. Low thoughts mean low behaviour, and after a brief orgy of exploitation low behaviour means a descending standard of life. The general greatness of the community, qualitatively as well as quantitatively, is the first condition for steady prosperity, buoyant, self-sustained, and

commanding credit. The Greek philosopher who laid the foundation of all our finer thoughts ended his most marvellous dialogue with the reflection that the ideal state could never arrive till philosophers are kings. Today, in an age of democracy, the kings are the plain citizens pursuing their various avocations. There can be no successful democratic society till general education conveys a philosophic outlook.

Philosophy is not a mere collection of noble sentiments. A deluge of such sentiments does more harm than good. Philosophy is at once general and concrete, critical and appreciative of direct intuition. It is not—or, at least, should not be—a ferocious debate between irritable professors. It is a survey of possibilities and their comparison with actualities. In philosophy, the fact, the theory, the alternatives, and the ideal, are weighed together. Its gifts are insight and foresight, and a sense of the worth of life, in short, that sense of importance which nerves all civilized effort. Mankind can flourish in the lower stages of life with merely barbaric flashes of thought. But when civilization culminates, the absence of a coördinating philosophy of life, spread throughout the community, spells decadence, boredom, and the slackening of effort.

Every epoch has its character determined by the way its populations re-act to the material events which they encounter. This reaction is determined by their basic beliefs—by their hopes, their fears, their judgments of what is worth while. They may rise to the greatness of an opportunity, seizing its drama, perfecting its art, exploiting its adventure, mastering intellectually and physically the network of relations that constitutes the very being of the epoch. On the other hand, they may collapse before the perplexities confronting them. How they act depends partly on their courage, partly on their intellectual grasp. Philosophy is an attempt to clarify those fundamental beliefs which finally determine the emphasis of attention that lies at the base of character.

Mankind is now in one of its rare moods of shifting its outlook. The mere compulsion of tradition has lost its force. It is our business —philosophers, students, and practical men—to re-create and reënact a vision of the world, including those elements of reverence and order without which society lapses into riot, and penetrated through and through with unflinching rationality. Such a vision is the knowledge which Plato identified with virtue. Epochs for which, within

the limits of their development, this vision has been widespread are the epochs unfading in the memory of mankind.

Our discussion has insensibly generalized itself. It has passed beyond the topic of Commercial Relations to the function of a properly concrete philosophy in guiding the purposes of mankind.

EPILOGUE TO PART I

At this stage we conclude the consideration of that group of ideas that most directly contributed to the civilization of the behaviour-systems of human beings in their intercourse with each other. This improvement depended on the slow growth of mutual respect, sympathy, and general kindliness. All these feelings can exist with the minimum of intellectuality. Their basis is emotional, and humanity acquired these emotions by reason of its unthinking activities amid the course of nature.

But mentality as it emerges into coördinated activity has a tremendous effect in selecting, emphasizing, and disintegrating. We have been considering the emergence of ideas from activities, and the effect of ideas in modifying the activities from which they emerge. Ideas arise as explanatory of customs and they end by founding novel methods and novel institutions. In the preceding chapters we have watched instances of their transition from one to other of these two modes of functioning.

Part II Cosmological

CHAPTER VII *LAWS OF NATURE*

SECTION I. The previous part of this book dealt with the influence exerted by the Platonic and Christian doctrines of the human soul upon the sociological development of the European races. In this second part of the book, I shall deal with the influence of scientific

ideas upon European culture, and with the more general cosmological ideas thus generated and presupposed.

It would be useless to attempt a history of science within this compass. Accordingly, I shall confine myself to the most general ideas at the base of the whole development of science. I mean the concepts of Speculation and of Scholarship, and the various notions of the Order of Nature, and of Nature itself. In short, my topic is 'Cosmologies, Ancient and Modern,' together with the variety of methods, speculative and scholarly, employed in their production. Special developments of learning will only be cited in order to exemplify the specializations of general ideas amid changing epochs of Western Culture.

Modern Europe and America have derived their civilization from the races whose countries border the Eastern Mediterranean. In the earlier chapters, Greece and Palestine were the regions providing the initial formulations of the ideas concerning the essence of human nature. When we examine the history of science, to these two countries we must add Egypt. These three countries are the direct ancestors of our modern civilization.

Of course there is a long tale of civilization behind them. Mesopotamia, Crete, Phœnicia, India, and China also contributed. But whatever of scientific or religious value has passed into modern life, finally reached us through the mediation of these three countries, Egypt, Greece, Palestine. Of these countries, Egypt provided the mature technology, arising from three thousand years of secure civilization, Palestine provided the final religious cosmology, Greece provided the clear-cut generalizations leading to philosophy and science. This logical lucidity also tinges the remaining legacy from Greece, its art and imaginative literature. Every Greek statue expresses the welding of beauty to regularity of geometrical form: every Greek play investigates the interweaving of physical circumstances arising from the Order of Nature with states of mind which issue from the urge of the Moral Order.

'Canst thou by searching find out God?' is good Hebrew, but it is bad Greek. The effort to comprehend the great fact which procures the order in the Universe urged Greek thinkers to that culmination when Plato and Aristotle defined the complex of general ideas forming the imperishable origin of Western thought. The work was only accomplished just in time. In the very lifetime of Aristotle the

political and cultural barriers collapsed; and the subsequent Hellenistic development at Alexandria and elsewhere was the joint enterprise of Greeks, Egyptians, Semites, and the mixed races of Syria and Asia Minor. The untroubled faith in lucidity within the depths of things, to be captured by some happy glance of speculation, was lost forever. Duller men were content with limited accuracy and constructed special sciences: thicker intellects gloried in the notion that the foundations of the world were laid amid impenetrable fog. They conceived God in their own image, and depicted him with a positive dislike of efforts after understanding beyond assigned methodologies. Satan acquired an intellectual character, and fell by reason of an indecent desire to understand his Creator. It was the downfall of Greece.

SECTION II. The progress of mankind proceeds by devious paths. The shift from the bright Hellenic age, whose final period was centred in Athens, to the Hellenistic age, with Alexandria as its intellectual capital, corresponds to a new direction of constructive genius. The special sciences were founded. Their principles were defined, their methods were determined, appropriate deductions were elicited. Learning was stabilized. It was furnished with methodologies, and was handed over to University professors of the modern type. Doctors of Medicine, Mathematicians, Astronomers, Grammarians, Theologians, for more than six hundred years dominated the schools of Alexandria, issuing text-books, treatises, controversies, and dogmatic definitions. Literature was replaced by Grammar, and Speculation by the Learned Tradition.

These men conventionalized learning. But they secured it. Their work survived two great religious revolutions, the rise of Christianity and the rise of Mahometanism. It provided both these religions with their philosophical theologies. It fitted them out with heresies and with orthodoxies.

In the Western Roman Empire, the Christian Church, armed with Hellenistic thought, captured the intellects of the victorious barbarians and civilized Western Europe up to the Arctic Ocean. Along the south of the Mediterranean the Mahometan conquerors carried Hellenistic thought, as coloured by the mentalities of Arabs, Jews, and Persians, through Africa into Spain. From Spain, the Mahometan and Jewish versions made contact with the Christian version of Alexandrian culture. This fusion produced the brilliant culmination

of Christian Scholasticism in the thirteenth century; and, in the seventeenth century, Spinoza.

The note of Hellenism is delight, speculation, discoursive literature: the note of Hellenistic Alexandria is concentration, thoroughness, investigation of the special types of order appertaining to special topics. The great Alexandrians were either right or wrong: Euclid either did, or did not make his text-book of Geometry logically coherent: the Ptolemaic doctrine of the heavens is true or false: Athanasius is directly opposed to Arius: and Cyril to Nestorius. The nearest analogues to the Alexandrian theological debates are the modern debates among mathematical physicists on the nature of the atom. The special topics differ slightly; but the methods and the men are identical.

It is unmeaning bluntly to ask of Plato, whether he be right or wrong, in the same exact sense in which we frame the question about the Alexandrians. When any eminent scholar has converted Plato into a respectable professor, by providing him with a coherent system, we quickly find that Plato in a series of Dialogues has written up most of the heresies from his own doctrines. It is as though Ptolemy had emitted the speculations of Aristarchus, and as though Athanasius had suggested the profanities of Arius.

I am not alluding to the mere fact that men change their opinions, with the advance of age, or with the advance or decay of knowledge. The important point is the way in which opinions are held, and the weight attached to particular modes of statement. St. Augustine changed his opinions. He not only published for all ages the tragic intensity of feeling which the conversion involved, but also he devoted himself to exact statements of his new doctrines. He remained a Platonist, and his interest in the doctrine of Grace was a Platonic interest in the exact expression of how finite human life can participate in the Divine Perfections. He performed an immense service to civilization by providing Western Europe with accurate definitions on great topics just before the oncoming of the Barbarians. He secured that western Christianity should persist as a civilizing influence, and not degenerate into hereditary superstition of the Abyssinian type. But his attitude to his own doctrines was very different from that of Plato. Consider some of Plato's phrases about his own ideas: 'If, then, Socrates, we find ourselves in many points unable to make our discourse of the generation of gods and the universe in

every way wholly consistent and exact, you must not be surprised. Nay, we must be well content if we can provide an account not less likely than another's; we must remember that I who speak, and you who are my audience, are but men and should be satisfied to ask for no more than the likely story.' *

Again:—'Perhaps they may be in a difficulty; and if this is the case, there is a possibility that they may accept a suggestion of ours respecting the nature of essence, having nothing of their own to offer.' †

Can we imagine Augustine urbanely approaching Pelagius with 'a suggestion of ours respecting the nature of Grace'? It is quite true that passages can be quoted from Plato, more particularly from *The Laws,* which would justify all the persecution of atheists that has disgraced Europe. But the passages quoted above give the general tone of the *Dialogues* in their handling of the precise expression of speculative notions.

SECTION III. In many ways Aristotle and Epicurus foreshadow the transition from Hellenic speculation to the exact scholarship of Alexandria. In both of them we find an effort towards system, explicitly stated and exactly phrased. Of course, Lucretius is our main authority for the Epicurean doctrines.

If we merely knew that great schools of exact scientific investigation had arisen in the succeeding generation, undoubtedly modern critical scholarship would have assigned to Aristotle's influence the honour of their origination. We can imagine the contrast which would have been drawn between the barrenness of mere speculation and the fruitfulness of Aristotle's power of detailed observation.

Unfortunately, cold fact points in exactly the opposite direction. In the first place Aristotle himself derived his own sources of thought from Plato's theoretical activity. He dissected fishes with Plato's thoughts in his head. He systematized the welter of Platonic suggestions, and in the course of his work he modified, improved, and spoilt. But he did introduce into sciences other than Astronomy the much-needed systematic practice of passing beyond theory to direct observation of details. Unfortunately this was the one aspect of his life which never had any direct influence on any succeeding epoch.

* The *Timaeus,* A. E. Taylor's translation.
† The *Sophist,* Jowett's translation.

Again, in point of fact the Alexandrian culture derived directly from Plato. Its thought was through and through Platonic both in science and theology. But it was not for nothing that Alexandria was situated in a land of old, secure technology. There were crafts and learned professions with traditions of detailed procedure stretching back for thousands of years. The schools of Alexandria were thronged with sons of priests, sons of metallurgists, sons of makers of implements for irrigation and agriculture, sons of land-surveyors. It is no wonder that the first emergence of modern scholarship studied in a modern university, took place when Platonic speculation was transferred to a land of old professional activity.

Undoubtedly the chasm between Hellenic mentality and mediæval scholastic learning was due to many influences accumulating their effects through a period of a thousand years. But the greatest gap in the transition is the first one, when the capital of Mediterranean learning was transferred from Athens to Alexandria. The general type of the cultural development of Western Civilization was then predetermined. How science should be developed: How mathematics should evolve: How religion, Jewish, Christian, Mahometan, should shape its various theologies. The modern world is primarily Alexandrian; and only for a short period of about a hundred years, to be placed somewhere between the Council of Constance and the Sack of Rome in 1527, did the Athenian tone of mind prevail: perhaps also earlier in the Italy of the Augustan epoch. The difference between the two, namely the Hellenic and the Hellenistic types of mentality, may be roughly described as that between speculation and scholarship. For progress, both are necessary. But, in fact, on the stage of history they are apt to appear as antagonists. Speculation, by entertaining alternative theories, is superficially sceptical, disturbing to established modes of prejudice. But it obtains its urge from a deep ultimate faith, that through and through the nature of things is penetrable by reason. Scholarship, by its strict attention to accepted methodologies, is superficially conservative of belief. But its tone of mind leans towards a fundamental negation. For scholars the reasonable topics in the world are penned in isolated regions, *this* subject-matter or *that* subject-matter. Your thorough-going scholar resents the airy speculation which connects his own patch of knowledge with that of his neighbour. He finds his fundamental concepts interpreted, twisted, modified. He has ceased to be king

of his own castle, by reason of speculations of uncomfortable generality, violating the very grammar of his thoughts. Pope Adrian the Sixth exhibited himself as a typical scholar by remarking that in Luther's theological works so many errors could be found that any tyro could point them out.

New directions of thought arise from flashes of intuition bringing new material within the scope of scholarly learning. They commence as the sheer ventures of rash speculation. They may fortunately obtain quick acceptance, or they may initiate a quarrel of scholars from which all tinge of speculation has faded. Pope Leo the Tenth voiced the vanishing Athenian epoch when he characterized the Lutheran disputes as a quarrel of monks.

Pure speculation, undisciplined by the scholarship of detailed fact or the scholarship of exact logic, is on the whole more useless than pure scholarship, unrelieved by speculation. The proper balance of the two factors in progressive learning depends on the character of the epoch in question and on the capacities of particular individuals. Also it is a curious fact, somewhat lost sight of in Greek thought, that, notwithstanding the law of the Golden Mean between contrasted components, yet a certain excessiveness seems a necessary element in all greatness. In some direction or other we must devote ourselves beyond what would be warranted by the analysis of pure reason.

One aspect of the adventure of ideas is this story of the interplay of speculation and scholarship, a strife sustained through the ages of progress. This history discloses the happy balance attained in periods of culminating greatness, and it also exhibits the tinge of excessiveness in all such peaks of achievement. Thereby it gives the reason for the tragic transience of supreme moments in human life.

Section IV. The notion of Law, that is to say, of some measure of regularity or of persistence or of recurrence, is an essential element in the urge towards technology, methodology, scholarship, and speculation. Apart from a certain smoothness in the nature of things, there can be no knowledge, no useful method, no intelligent purpose. Lacking an element of Law, there remains a mere welter of details with no foothold for comparison with any other such welter, in the past, in the future, or circumambient in the present. But the expression of this notion of Law with due accuracy, and with due regard to what in fact is presupposed in human purposes, is a matter

of extreme difficulty. Analogously to the histories of all the more general ideas, the notion of Law has entered into the explicit consciousness of various epochs under every variety of specialization, arising from its coalescence with other components in the popular cosmology.

The difficulty in all such notions of supreme generality is that conscious attention is not naturally directed to any factor which is a 'matter of course' in experience. Attention is riveted upon 'news,' and 'news' involves some aroma of capriciousness. It is useless to recur to periods of human history which lie beyond the reach of direct evidence. But anthropologists report the almost universal prevalence of tribal ceremonies having reference to the succession of the yearly seasons, more particularly to the Spring, the Harvest, and Mid-winter. Undoubtedly, as we view them now, there is a reference to agriculture in such celebrations. Now agriculture marks the first decisive step towards modern civilization. Its introduction marks the arrival of a stage of high grade reflection upon the course of events. It requires a forecast of the course of nature months ahead. Many an ape-man must have snatched up a stone wherewith to hit somebody, either another man or other animal, on the head, without any reflection upon the course of nature beyond the next few minutes. Also he might notice that some stones are better than others as lethal weapons, and he might even help them out by chipping them. He is then approaching civilization. But he—or more probably, she—has crossed the great divide, when he puts seeds into a patch of earth and waits for a season.

It is obvious that seasonal ceremonies must extend backwards in time far beyond the introduction of agriculture. The differences between the seasons impose differences of behaviour upon all living things, vegetables and animals alike. The seasonal urge towards change of habit, hibernation or migration, must have begotten some expression of emotional restlessness. The interest of agriculture comes in when we consider the later interpretation of the seasonal ceremonies in which the tribe had been indulging for countless ages. Civilization did not start with a social contract determining modes of behaviour. Its earliest effort was the slow introduction of ideas explanatory of modes of behaviour and of inrushes of emotion which already dominated their lives. Undoubtedly ideas modified the

practice. But in the main practice precedes thought; and thought is mainly concerned with the justification or the modification of a pre-existing situation.

Now, apart from the practice of agriculture, animal habits are mainly based on the massive recurrence of the seasons, heat and frost, rain and drought, day and night. There was stolid recurrent matter of fact, with accompanying rhythms of emotion and ritual. Vagrant questions may have disturbed exceptional minds. But there was little to provoke tribal interest in explanation. There must have been some instances to provoke attention, because there was, in fact, among some tribes of our ancestors, a drift towards better ways of life. But I am seeking to determine the dividing line after which the curiously quick acceleration of civilized thought may conceivably have arisen. In the earlier stage the convenient unit of time is of the order of a hundred thousand years. In the later phases it shortens up to ten thousand years, to five thousand years, to one thousand years, to a hundred years.

Probably there was a concurrence of many causes. But among such causes the introduction of agriculture must be given a high place for its effectiveness in quickening progress. It at once introduced the capriciousness of the weather as a major topic of tribal interest. Also it provoked attention to the mystery of germination, and to the dependence of vegetable growth upon the seasonal phases. It compelled the tribe to descend from passive acquiescence in a general matter of course towards active interest in the details. It led to a search for precautions, and discovery requires understanding. Of course, as we all know, the novel situation did not require every tribe to advance. Also the masses of mankind are always liable to reach some stable level of custom, and to halt progress there. But human life had then reached a stage at which obvious problems were presented to the more active minds, wherever such existed.

We inherit legends, weird, horrible, beautiful, expressing in curious, specialized ways the interweaving of law and capriciousness in the mystery of things. It is the problem of good and evil. Sometimes the law is good and the capriciousness evil; sometimes the law is iron and evil and the capriciousness is merciful and good. But from savage legends up to Hume's civilized *Dialogues on Natural Religion*, with the conversation between Job and his friends as an

intermediate between the two, the same problem is discussed. Science and technology are based upon law. Human behaviour exhibits custom mitigated by impulse. What exactly do we mean by the notion of the Laws of Nature?

SECTION V. At the present time, there are prevalent four main doctrines concerning the Laws of Nature: the doctrine of Law as immanent, the doctrine of Law as imposed, and the doctrine of Law as observed order of succession, in other words, Law as mere description, and lastly the later doctrine of Law as conventional interpretation. It will be convenient first to discuss these four alternative doctrines from the standpoint of today. We shall then be in a better position to understand the chequered history of the notion in civilized thought.

By the doctrine of Law as immanent it is meant that the order of nature expresses the characters of the real things which jointly compose the existences to be found in nature. When we understand the essences of these things, we thereby know their mutual relations to each other. Thus, according as there are common elements in their various characters, there will necessarily be corresponding identities in their mutual relations. In other words, some partial identity of pattern in the various characters of natural things issues in some partial identity of pattern in the mutual relations of those things. These identities of pattern in the mutual relations are the Laws of Nature. Conversely, a Law is explanatory of some community in character pervading the things which constitute Nature. It is evident that the doctrine involves the negation of 'absolute being.' It presupposes the essential interdependence of things.

There are some consequences to this doctrine. In the first place, it follows that scientists are seeking for explanations and not merely for simplified descriptions of their observations. In the second place the exact conformation of nature to any law is not to be expected. If all the things concerned have the requisite common character, then the pattern of mutual relevance which expresses that character will be exactly illustrated. But in general we may expect that a large proportion of things do possess the requisite character and a minority do not possess it. In such a case, the mutual relations of these things will exhibit lapses when the law fails to obtain illustration. In so far as we are merely interested in a confused result of many instances, then the law can be said to have a statistical character. It is now

the opinion of physicists that most of the laws of physics, as known in the nineteenth century, are of this character.

Thirdly, since the laws of nature depend on the individual characters of the things constituting nature, as the things change, then correspondingly the laws will change. Thus the modern evolutionary view of the physical universe should conceive of the laws of nature as evolving concurrently with the things constituting the environment. Thus the conception of the Universe as evolving subject to fixed, eternal laws regulating all behaviour should be abandoned. Fourthly, a reason can now be produced why we should put some limited trust in induction. For if we assume an environment largely composed of a sort of existences whose natures we partly understand, then we have some knowledge of the laws of nature dominating that environment. But apart from that premise and apart from the doctrine of Immanent Law, we can have no knowledge of the future. We should then acknowledge blank ignorance, and not make pretences about probability.

Fifthly, the doctrine of Immanent Law is untenable unless we can construct a plausible metaphysical doctrine according to which the characters of the relevant things in nature are the outcome of their interconnections, and their interconnections are the outcome of their characters. This involves some doctrine of Internal Relations.

Finally, the doctrine of Immanence is through and through a rationalistic doctrine. It is explanatory of the possibility of understanding nature.

Section VI. The doctrine of Imposed Law adopts the alternative metaphysical doctrine of External Relations between the existences which are the ultimate constituents of nature. The character of each of these ultimate things is thus conceived as its own private qualification. Such an existent is understandable in complete disconnection from any other such existent: the ultimate truth is that it requires nothing but itself in order to exist. But in fact there is imposed on each such existent the necessity of entering into relationships with the other ultimate constituents of nature. These imposed behaviour patterns are the Laws of Nature. But you cannot discover the natures of the relata by any study of the Laws of their relations. Nor, conversely, can you discover the laws by inspection of the natures.

The explanation of the doctrine of Imposition both suggests a certain type of Deism, and conversely it is the outcome of such a

Deistic belief if already entertained. For example, we know from Newton's own statements that this was exactly how the Deistic problem presented itself to him. He definitely stated that the correlated modes of behaviour of the bodies forming the solar system required God for the imposition of the principles on which all depended. He was certainly doubtful, indeed more than doubtful, as to whether the Law of Gravity was the ultimate statement of principles imposed by God. But he certainly thought that the conception of the solar system exhibited in his Principia was sufficiently ultimate to make obvious the necessity of a God imposing Law. Newton was certainly right to this extent, that the whole doctrine of Imposition is without interest apart from the correlative doctrine of a transcendent imposing Deity. This is also a Cartesian doctrine.

The doctrine of Imposition very naturally follows from Descartes' notion of 'substance.' Indeed the phrase 'requiring nothing but itself in order to exist' occurs in his *Principles of Philosophy*. The whole Cartesian apparatus of Deism, substantial materialism, and imposed law, in conjunction with the reduction of physical relations to the notion of correlated motions with mere spatio-temporal character, constitutes the simplified notion of Nature with which Galileo, Descartes, and Newton finally launched modern science on its triumphant career. If success be a guarantee of truth, no other system of thought has enjoyed a tithe of such success since mankind started on its job of thinking. Within three hundred years it has transformed human life, in its intimate thoughts, its technologies, its social behaviour, and its ambitions.

It follows from the Deism, which is part of the whole conception, that the Laws of Nature will be exactly obeyed. Certainly, what God meant he did. When he said, Let there be light, there was *light* and not a mere imitation or a statistical average. Thus the statistical notion, though it may explain some facts of our confused perception, is not applicable to the ultimate, imposed laws.

But even before Descartes, it was the implicit belief in some form of imposition, with its consequent exactness, that constituted the motive force in scientific research. Why should educated men have believed that there was anything to find out? Suppose that the doctrine of immanence had prevailed in Europe and in Mahometan Asia. Why should men assume that there were definite laws which

even beyond the limits of meticulous observation underlie the apparent capriciousness of physical details? There are certain grand obvious uniformities, Day follows Night, and again relapses into Night, the Mountains endure, and Birth proceeds. But these grand regularities are shot through and through with details apparently capricious. The very savages saw that, and tremblingly worshipped malignant demons. But civilized men, who understand the doctrine of immanence, should draw the conclusion that the dominance of common traits of character throughout the constituents of nature is only very partial. There is no reason why it should be otherwise. A restless search for detailed explanation is futile, based upon no approach to probability. If in the past men had believed thus, today there would be no science. And even today, how little do we know about physiology. Also an individual electron is a rare bird whose behaviour is unpredictable: our information about electrons mostly concerns flocks numbering millions. What reason is there to expect success if we seek to push the reign of law one step further towards minute detail? Indeed, physicists in their recent researches have disclosed a novel illustration of capriciousness. These men, trained in the Positivist doctrine, have at once suggested the uselessness of further search for 'law.' Unless the psychology of mental behaviour still include some traces derived from the notion of Deistic imposition, even today the progress of science would cease by reason of the failure of hope. A considerable proportion of present-day philosophy is devoted to the endeavour by means of subtle argument to evade this plain inexorable conclusion.

Lastly apart from some notion of imposed Law, the doctrine of immanence provides absolutely no reason why the universe should not be steadily relapsing into lawless chaos. In fact, the Universe, as understood in accordance with the doctrine of Immanence, should exhibit itself as including a stable actuality whose mutual implication with the remainder of things secures an inevitable trend towards order. The Platonic 'persuasion' is required.

SECTION VII. Of the three earlier theories, there remains the Positivist doctrine concerning Law, namely, that a Law of Nature is merely an observed persistence of pattern in the observed succession of natural things: Law is then merely Description. There is an attractive simplicity about this doctrine. The two preceding doc-

trines lead us to the dubieties of metaphysics, such as the doctrine of internal relations or the existence and nature of God. But this third doctrine evades all such difficulties.

It presupposes that we have direct acquaintance with a succession of things. This acquaintance is analysable into a succession of things observed. But our direct acquaintance consists not only in distinct observations of the distinct things in succession, but also it includes a comparative knowledge of the successive observations. Acquaintance is thus cumulative and comparative. The laws of nature are nothing else than the observed identities of pattern persisting throughout the series of comparative observations. Thus a law of nature says something about things observed and nothing more.

The pre-occupation of science is then the search for simple statements which in their joint effect will express everything of interest concerning the observed recurrences. This is the whole tale of science, *that* and nothing more. It is the great Positivist doctrine, largely developed in the first half of the nineteenth century, and ever since growing in influence. It tells us to keep to things observed, and to describe them as simply as we can. This is all we can know. Laws are statements of observed facts. This doctrine dates back to Epicurus, and embodies his appeal to the plain man, away from metaphysics and mathematics. The observed facts of clear experience are understandable, and nothing else. Also 'understanding' means 'simplicity of description.'

Without doubt this Positivist doctrine contains a fundamental truth about scientific methodology. For example, consider the greatest of all scientific generalizations, Newton's Law of Gravitation:—Two particles of matter attract each other with a force directly proportional to the product of their masses and inversely proportional to the square of their distance. The notion of 'force' refers to the notion of the addition of a component to the vector acceleration of either particle. It also refers to the notion of the masses of the particles. Again the notion of mass is also explicitly referred to in the statement. Thus the mutual spatial relations of the particles, and their individual masses, are required for the Law. To this extent the Law is an expression of the presumed characters of the particles concerned. But the form of the Law, namely the product of the masses and the inverse square of the distance, is purely based upon description of observed fact. A large part of Newton's *Principia* is devoted

to a mathematical investigation proving that the description is adequate for his purposes; it collects many details under one principle. Newton himself insisted upon this very point. He was not speculating: he was not explaining. Whatever your cosmological doctrines may be, the motions of the planets and the fall of the stones, so far as they have been directly measured, conform to his Law. He is enunciating a formula which expresses observed correlations of observed facts.

Without the shadow of a doubt, all science bases itself upon this procedure. It is the first rule of scientific method,—Enunciate observed correlations of observed fact. This is the great Baconian doctrine, namely, Observe and observe, until finally you detect a regularity of sequence. The scholastics had trusted to metaphysical dialectic giving them secure knowledge about the nature of things, including the physical world, the spiritual world, and the existence of God. Thence they deduced the various laws, immanent and imposed, which reigned throughout Nature.

Another difference between Scholasticism and the Moderns is in respect to criticism and reliance upon authority. But this distinction has been overstressed and misunderstood. The Scholastics were intensely critical, but they were critical within a different sphere of thought from that occupying the Moderns. Again modern scientists rely upon authority, but they rely upon different authorities from those to whom the Scholastics appealed. Undoubtedly the later Scholastics were uncritical in their appeal to their chosen authority, Aristotle, especially and most unfortunately in regard to his physics. The moderns push their criticism further. But the Scholastics and the modern Scientists are alike scholars of the Alexandrian type. They have the same sort of merit and the same sort of defect. Also, the sort of person who was a scholastic doctor in a mediaeval university, today is a scientific professor in a modern university. Again the Scholastics differed among themselves in opinion widely. The earlier set were not even Aristotelians, the later set were not all Thomists. Analogously, modern scientists differ among themselves, about details and about the general doctrine of the Laws of Nature.

Within the sphere of dialectic debate, the Scholastics were supremely critical. They trusted Aristotle because they could derive from him a coherent system of thought. It was a criticized trust. Unfortunately, they did not reflect that some of his main ideas de-

pended upon his direct acquaintance with experienced fact. They trusted to the logical coherence of the system as a guarantee of the unrestricted relevance of his primary notions. They thus accepted his confusion—when there was confusion—of superficial aspects with fundamental principles of widest generality. Their method for the furtherance of natural knowledge was endless debate, unrelieved by recurrence to direct observation. Unfortunately also their instrument of debate, Aristotelian Logic, was a more superficial weapon than they deemed it. Automatically it kept in the background some of the more fundamental topics for thought. Such topics are the quantitative relations examined in mathematics, and the complex possibilities of multiple relationship within a system. All these topics, and others, were kept in the background by Aristotelian logic.

Fortunately the scholastic age of Alexandrian scholarship dominated Europe for centuries, and bestowed upon civilization priceless treasures of thought. It was an age of immense progress. But a scholarly age works within rigid limitations. Fortunately, a revival of Hellenism overwhelmed the Hellenistic unity of the Middle Ages. Plato arose as if from his tomb. Vagrant speculation and direct observation broke up the scholarly system. New interests, new Gods, prevailed. The new basis for thought was the report upon facts, directly observed, directly employed. Fortunately, in the subsidence of the Italian Renaissance of the fifteenth century, the drama of the transference of culture from Athens to Alexandria was again repeated. Europe gradually entered upon a new scholarly age. The modern historian appeared, the modern critical literature appeared, the modern man of science appeared, modern technology appeared. The old Egyptian metallurgists, the Semitic mathematicians, and the mediaeval scholastics were avenged.

But modern scholarship and modern science reproduce the same limitations as dominated the bygone Hellenistic epoch, and the bygone Scholastic epoch. They canalize thought and observation within predetermined limits, based upon inadequate metaphysical assumptions dogmatically assumed. The modern assumptions differ from older assumptions, not wholly for the better. They exclude from rationalistic thought more of the final values of existence. The intimate timidity of professionalized scholarship circumscribes reason by reducing its topics to triviality, for example, to bare sensa and to tautologies. It then frees itself from criticism by dogmatically

handing over the remainder of experience to an animal faith or a religious mysticism, incapable of rationalization. The world will again sink into the boredom of a drab detail of rational thought, unless we retain in the sky some reflection of light from the sun of Hellenism.

CHAPTER VIII *COSMOLOGIES*

SECTION I. At the close of the previous chapter we were left with four antagonistic schools of thought regarding the analysis of the notion of Law, The School of Immanence, The School of Imposition, The Positivist School of Observation, that is to say, of mere Description, and finally the School of Conventional Interpretation. We find that each of these schools could produce grave reasons in confirmation of its own doctrine.

There is no greater hindrance to the progress of thought than an attitude of irritated party-spirit. Urbanity, the urbanity of Plato and, if we may trust his *Dialogues,* the urbanity of Athenian society, were part of the intellectual genius of those times. The vicious antagonisms of subsequent theologians, some centuries later, hid from them considerations which they ought never to have forgotten, and have hidden from us the metaphysical genius of their own contributions to thought.

We will recommence by scanning the history of these doctrines of Natural Law, with the view of determining their exact points of divergence, and the measure of conciliation of which they are capable. In the previous chapter Plato's urbane preface to a philosophical suggestion was quoted. The suggestion itself is now relevant to the present lecture:—

'My suggestion would be, that anything which possesses any sort of power to affect another, or to be affected by another even for a moment, however trifling the cause and however slight and momentary the effect, has real existence; and I hold that the definition of being is simply power.' *

In the subsequent conduct of the dialogue Plato rises to the height of his genius as a metaphysician. But he also wrestles with the

* *Sophist,* 247, Jowett's translation.

difficulty of making language express anything beyond the familiarities of daily life. It is misleading to study the history of ideas without constant remembrance of the struggle of novel thought with the obtuseness of language.

Also it is interesting to notice that, according to Plato, the distinguishing mark of the Philosopher in contrast to the Sophist is his resolute attempt to reconcile conflicting doctrines, each with its own solid ground of support. In the history of ideas the doctrine *of* Speculation is at least as important as the doctrines *for* Speculation.

SECTION II. But, to return to Plato's suggestion—'and I hold that the definition of being is simply power.'

This statement can be construed in terms of the notion of imposed law, namely, that it is an external imposition on each existent, that it be correlated with determinate causal action on other such existents. But such an interpretation neglects the exact wording. Plato says that it is the *definition* of being that it exert power and be subject to the exertion of power. This means that the essence of being is to be implicated in causal action on other beings. It is the doctrine of Law as immanent. Further, a few sentences later he proceeds:—'. . . being, as being known, is acted on by knowledge, and is therefore in motion, for that which is in a state of rest cannot be acted upon as we affirm. . . . Can we imagine being to be devoid of life and mind, and to remain in awful unmeaningness an everlasting fixture?'

Notice that in this argument, that which is not acted upon is a fixture. Plato denies that being can be conceived 'in awful unmeaningness an everlasting fixture.' It is therefore acted upon. This agrees with his primary definition, that 'being' is the agent in action, and the recipient of action. Thus, in these passages Plato enunciates the doctrine that 'action and reaction' belong to the essence of being: though the mediation of 'life and mind' is invoked to provide the medium of activity. This notion of a medium, connecting the eternality of being with the fluency of becoming, takes many shapes in Plato's *Dialogues*. Very probably, indeed almost certainly, passages inconsistent with this doctrine can be found in the *Dialogues*. For the moment, the interesting fact is that in these passages in this Dialogue we find a clear enunciation of the doctrine of Law as immanent.

The early, naïve trend of Semitic monotheism, Jewish and Mahom-

etan, is towards the notion of Law imposed by the fiat of the One God. Subsequent speculation wavers between these two extremes, seeking their reconciliation. In this, as in most other matters, the history of Western thought consists in the attempted fusion of ideas which in their origin are predominantly Hellenic, with ideas which in their origin are predominantly Semitic. The modern scholar, with his tinge of speculation, is an Egyptian employing his wisdom upon his Hellenic and Semitic heritage.

In this instance, the extremes of the two doctrines of Law lead on the one hand to the extreme monotheistic doctrine of God, as essentially transcendent and only accidentally immanent, and on the other hand to the pantheistic doctrine of God, as essentially immanent and in no way transcendent.

Plato in the *Timaeus* affords an early instance of this wavering between the two doctrines of Law, Immanence and Imposition. In the first place, Plato's cosmology includes an ultimate creator, shadowy and undefined, imposing his design upon the Universe. Secondly, the action and reaction of the internal constituents is—for Plato—the self-sufficient explanation of the flux of the world:—'Nothing was given off from it, nothing entered it,—there was nothing but itself.'

We have here been examining the basic notion of the initial cosmology which dominated the world, Pagan, Christian, and Mahometan, before the rise of the modern period. It was modified by Aristotle, by the Alexandrians, by the Scholastics. But this fusion of the doctrines of Imposition and Immanence, with adjustments this way or that way, is the great conception which reigned supreme till the beginning of the seventeenth century.

SECTION III. But Greek thought provided a rival cosmology, in the shape of the Atomic theory, as adumbrated by Democritus, systematized by Epicurus, and as finally explained in Epic shape by Lucretius. According to Lucretius the world is an interminable shower of atomic particles, streaming through space, swerving, intermingling, disentangling their paths, recombining them. For this doctrine qualitative differences are merely the statistical expression of geometrical patterns of intermingled paths, the outcome of swerving, combined with a finite number of diversities of shape.

Plato and Lucretius both appeal to geometry, Plato to the regular solids, and Lucretius to the shapes of paths, and unspecified shapes

of atoms. In this respect, their general attitude has been sustained by modern science. It seems necessary however for Epicurus to treat space and motion with the metaphysical naïvete exhibited later in Newton's *Principia.* Plato's doctrine of space, as stated in the *Timaeus,* has a superior metaphysical subtlety; although the Platonic doctrine of a Receptacle, intrinsically devoid of any geometrical form, has some analogy to the doctrine of the 'Void' in Lucretius. It is probable however that if Lucretius had possessed the penetration to explain Epicurus further, he would have found it necessary to endow his Void with exactly those geometrical forms which Plato denied to his Receptacle considered in abstraction, and which Aristotle denied to his Matter in abstraction.

Plato's cosmology tends to a fusion of the doctrines of Imposition and Immanence; the Atomic Theory of Epicurus lends itself most readily to a fusion of the doctrines of Imposition and of Description.

The reason for this distinction between the two cosmologies is that for Plato behaviour is a function of the various characters of the things concerned—the intelligent activities of indwelling souls, and the geometric necessities of the indwelling shapes. But for Epicurus the paths of the atoms are derived from no necessities of their natures. It is intrinsic to their natures that they partake of spatial relations and are moveable. But the special path of a special atom seems to be a fact entirely extrinsic to its nature. The modern wave-theory of the atom sides with Plato rather than with Democritus: Newtonian dynamics sides with Democritus against Plato. Some passages of Lucretius surreptitiously introduce the doctrine of immanence. What Lucretius mainly cared about was the reign of law as opposed to the capricious intervention of demons and gods, to be coaxed by superstition.

As to the paths of the atoms, two views are possible. One theory can conceive them as imposed, and imposition requires a transcendent God as imposer. This is practically the cosmology adopted by Newton. The Newtonian forces, whatever their ultimate mathematical formulation, are nothing else than the imposed conditions provided by God. This point of view was the working formula of the eighteenth century. God made his appearance in religion under the frigid title of the First Cause, and was appropriately worshipped in white-washed churches.

Another theory as to the paths can be adopted by the Positivist

School of Mere Description. For this reason, the atomic theory, of the Lucretian type, has always been a favorite first principle of cosmology with this School of Thought. The paths of the molecules can be ascribed to mere chance. They are random distributions, each path being entirely disconnected from any other path, and each continuation of one path being unconditioned by the earlier portion of the same path.

Thus the world, as we know it, exhibits for our confused perception an involution of paths and a concatenation of circumstances which have arisen entirely by chance. We can describe what has happened, but with that description all possibility of knowledge ends.

Lucretius wavers between the notion of imposed law and the notion of chance. For example:—'This point too we wish you to apprehend: when bodies are borne downwards sheer through void by their own weights, at quite uncertain times and uncertain spots they push themselves a little from their course: you just and only just can call it a change of inclination. If they were not used to swerve, they would all fall down, like drops of rain, through the deep void, and no clashing would have been begotten nor blow produced among the first-beginnings [i.e. the atoms]: thus nature never would have produced aught.' *

But he rigidly limits his suggestion of chance:— †

'But lest you haply suppose that living things alone are bound by these conditions, such a law keeps all things within their limits.'

The objection to the extreme Positivist doctrine at once suggests itself, that the enormous aspect of regular evolution through vast regions embracing the remotest star-galaxies, and through vast periods of time, is an unlikely product of mere chance.

There are two answers to this objection. In the first place, there is plenty of time and plenty of space. We are dealing with all space, from infinity to infinity, we are dealing with all time from eternity to eternity, and we are dealing with the unbounded wealth of all existence, to be comprehended in terms of no finite number. In any finite region of space and time, with its finite cargo of atoms, any pre-conceived arrangement of paths, however simple or however

* Book II, lines 216–224. Translated by H. A. J. Monro, published separately in Bohn's series, by G. Bell and Sons, Ltd.: Cf. also Cyril Bailey's translation, *Lucretius on the Nature of Things* (Oxford University Press, 1929).

† Cf. Book II, lines 718, 719.

complex, is equally unlikely, indeed there is an infinite probability against it. But we are not dealing with a pre-conceived concept, we observe what in fact is the case in a limited region. Something must be the case, and what we have observed is what in fact has been the case. There is nothing pre-conceived, and thus there is no question of infinite improbability. It is true that expectations float through our minds, but they are vague memories of what in fact has happened, combined with suggestions as to the more detailed analysis of past fact. The fact in the past is neither probable nor improbable, it is what in fact took place within the ambit of our observation.

The second answer takes the same point of view as that derived from the doctrine of immanence. There is no need—indeed there is not the slightest reason—to exaggerate the order in the spatio-temporal region under our observation. In the remote regions and epochs we have only intelligence of very general aspects of order. That is all we know. In the present epoch we have more detail, but our observation is rough, inaccurate, and sporadic. Again, that is all we know. We must not ascribe, we must not expect, one step beyond our direct knowledge. The Positivist has no foothold on which he can rely for speculation beyond the region of direct observation.

Section IV. The great Positivist school of thought, whose epic is the poem of Lucretius, at the present time reigns supreme in the domain of science. Its aim is to confine itself to fact, with a discard of all speculation. Unfortunately, among all the variant schools of opinion, it is the one which can least bear confrontation with the facts. It has never been acted on. It can never be acted on, for it gives no foothold for any forecast of the future around which purpose can weave itself.

But before confronting Positivism with the practice of mankind, it is interesting to note that atomism has taken on a new form of modern thought. Epistemology has arisen, in its function of a critic of all pretensions to knowledge. Today, the question, How do we know, takes precedence of the question,—What do we know.

Again, the doctrine of atomism re-appears. The atomism of Democritus in the science of Cosmology is replaced by the atomism of Hume in the science of Epistemology. Epicurus enunciates the doctrine that the ultimate elements of the physical universe are

physical atoms, showering through space with paths associated in complexes. Hume enunciates the doctrine that the ultimate elements, subjectively given in the activity of knowing, are the impressions of sensation, showering through the stream of experience, associated as memories, provocative of emotions and reflexions, and expectations. But for Hume, each impression is a distinct existence arising in the soul from unknown causes. Epicurus bases himself upon an epistemology closely allied to that of Hume.

Positivism has seized on Hume's atomism, with Hume himself as its leader. The task of science is explained to be merely the formulation of observed identities of pattern persistent and recurrent in each stream of experience. But since Hume is dealing with subjective experience, he can add a corollary not open to the more objective doctrine of Epicurus. Hume adds that we expect the recurrences observed in the past, also to recur in the future. At this stage, Hotspur's question arises in our mind, 'But will they come, when you do call for them?' To this question Hume, following the example of Glendower, returns no answer. It is an observed fact in the past that expected recurrences have recurred. But Positivistic science is solely concerned with observed fact, and must hazard no conjecture as to the future. If observed fact be all we know, then there is no other knowledge. Probability is relative to knowledge. There is no probability as to the future within the doctrine of Positivism.

Of course most men of science, and many philosophers, use the Positivistic doctrine to avoid the necessity of considering perplexing fundamental questions—in short, to avoid metaphysics—, and then save the importance of science by an implicit recurrence to their metaphysical persuasion that the past does in fact condition the future.

Indeed, as Hume pointed out, human life cannot be carried on without this persuasion. In this way the Positivistic doctrine of today bases itself on some form of atomism, objective or subjective, and deduces that the sole occupation of science is to elaborate simple descriptions of things observed.

There is a curious misconception that somehow the mathematical mysteries of Statistics help Positivism to evade its proper limitation to the observed past. But statistics tell you nothing about the future unless you make the assumption of the permanence of statistical form. For example, in order to use statistics for prediction, assump-

tions are wanted as to the stability of the mean, the mode, the probable error, and the symmetry or skewness of the statistical expression of functional correlation. Mathematics can tell you the consequences of your beliefs. For example, if your apple is composed of a finite number of atoms, mathematics will tell you that the number is odd or even. But you must not ask mathematics to provide you with the apple, the atoms, and the finiteness of their number. There is no valid inference from mere possibility to matter of fact, or, in other words, from mere mathematics to concrete nature.

SECTION V. It is now time to confront the Positivist doctrine with the facts of the History of Science. We want to discover the type of purpose exhibited in the practices of men of science. In order to avoid the suspicion of biased selection, consider the last discovery, which at the time of writing this chapter, has occupied a leading position in American newspapers. I mean the discovery of the new planet by the Lowell Observatory in Arizona. The final interpretation of this discovery is irrelevant: Nature, even in the act of satisfying anticipation, often provides a surprise. The story is typical of the previous discovery of Neptune, and of many discoveries of the faint members of double stars, and of the famous empirical term in the formula for the moon's motion.

The recent discovery is based upon the observed deviations of the orbits of the planets Uranus and Neptune from the calculated order. This calculation embraces the effect produced by all the previously known bodies of the solar system upon the motions of these two planets, assuming the Law of Gravitation. But their observed motions deviate slightly from their orbits as thus calculated. There is however no difficulty in producing a mathematical formula which describes the observed deviation. Such a formula will be of the most elementary mathematical character. It will consist of a few terms involving trigonometrical sines and cosines, with certain numerical components defining their periods, with other numerical components defining their amplitudes, and other numerical components defining their epochs—or in modern popular phraseology, their 'zero times.' Altogether a description of charming simplicity, which would have delighted Plato by its exemplification of his most daring speculations as to the future of mathematics.

Every Positivist must have been completely satisfied. A simple description had been evolved which fitted the observed facts. They

could now relapse into their unexplained persuasion that in the future these formulæ would continue to describe the motions of Uranus and Neptune. Positivism had exhausted its message. But astronomers were not satisfied. They remembered the law of Gravitation. Percy Lowell calculated the direction and magnitude of the vector component of acceleration, directed to an imaginary point moving round the sun in an elliptic path, even more remote than the orbit of Neptune. He succeeded in choosing his assumed path, so that the magnitude of the acceleration varies as the inverse square of the distance between Neptune and the moving point. A new description had been discovered, requiring some complex mathematics to connect it with the successive positions of Uranus, but conforming to the general form of Newton's Law. There has been a gain in generality, pleasing if you cherish a virtuosity in descriptions. But we have forgotten the main interest:—We have only got to look in the sky, towards Percy Lowell's moving point, and we shall see a new planet. Certainly we shall not. All that any person has seen is a few faint dots on photographic plates, involving the intervention of photography, excellent telescopes, elaborate apparatus, long exposures and favourable nights. The new explanation is now involved in the speculative extension of a welter of physical laws, concerning telescopes, light, and photography, laws which merely claim to register observed facts. It is involved in the speculative application of such laws to particular circumstances within the observatories, for which circumstances these laws are not concurrently verified. The result of this maze of speculative extensions is to connect the deviations of Uranus and Neptune with the dots on the photographic plates.

This narrative, framed according to the strictest requirements of the Positivist theory, is a travesty of the plain facts. The civilized world has been interested at the thought of the newly discovered planet, solitary and remote, for endless ages circling the sun and adding its faint influence to the tide of affairs. At last it is discovered by human reason, penetrating into the nature of things and laying bare the necessities of their interconnection. The speculative extensions of laws, baseless on the Positivist theory, are the obvious issue of speculative metaphysical trust in the material permanences, such as telescopes, observatories, mountains, planets, which are behaving towards each other according to the necessities of the universe, including theories of their own natures. The point is, that speculative

extension beyond direct observation spells some trust in metaphysics, however vaguely these metaphysical notions may be entertained in explicit thought. Our metaphysical knowledge is slight, superficial, incomplete. Thus errors creep in. But, such as it is, metaphysical understanding guides imagination and justifies purpose. Apart from metaphysical presupposition there can be no civilization.

There is a moral to be drawn as to the method of science. All scientific progress depends on first framing a formula giving a general description of observed fact. Lowell worked with such a formula in front of him, namely, the simple mathematical expression for the deviations. At one stage, the method of all discovery conforms to the Positivist doctrine. There can be no doubt that, with this restriction of meaning, the Positivist doctrine is correct.

Certain branches of science halt for centuries in this stage. Then their votaries embrace the unguarded Positivist doctrine. There is however a motive of unrest which urges scientists beyond mere satisfaction with the simple description, beyond even the *general* description. It is the desire to obtain the *explanatory* description which may justify the speculative extension of Laws, beyond actual, particular instances of observation.

This urge towards explanatory description provides the interplay between science and metaphysics. The doctrines of metaphysics are modified, so as to be capable of providing the explanation, and the explanations of science are framed in terms of the popular metaphysics lingering in the imaginations of these scientists.

One aspect of the history of thought from the time of Plato to the present day is the struggle between metaphysicians and Positivists over the interpretation of the Laws of Nature. The Greeks, as distinguished from the Alexandrians, are to be looked on as the discoverers of ideas, rather than their systematizers. Thus it is not surprising, that the attitude of Plato on this topic is not as clearly defined as the preceding quotations might imply. In some of his Dialogues his attention is fixed on the distinction between the eternal world of ideas, completely open to the understanding, and the fluent world disclosed by the senses which fails to participate with any exact clarity in the eternal forms. To that extent the sensible world is closed to the understanding. Its history is reduced to matter of fact, incapable of complete rationalization. It is but a short step from the Plato who composed the myth of the shadows on the wall of the cave

to the full Positivist doctrine of Hume [i.e., the Hume of the *Treatise*], Mill, Comte and Huxley. The main distinction between Plato in this mood and the Moderns—and it is a great distinction—is that the Platonic emphasis on the eminent reality of the eternal world of ideas must be replaced by the nominalism of most of these moderns.

But in his later Dialogues Plato's interest is concentrated on cosmology; and, as the quotations show, his final judgment, or the decay of his old age, leads him to an intermediate position between the doctrines of Immanent Law, and of Imposed Law.

SECTION VI. It was Plato in his later mood who put forward the suggestion, 'and I hold that the definition of being is simply power.' This suggestion is the charter of the doctrine of Immanent Law.

The next important landmark in the history of this doctrine is provided by the theological Alexandrians, some four to six hundred years later. It is customary to under-value theology in a secular history of philosophical thought. This is a mistake, since for a period of about thirteen hundred years the ablest thinkers were mostly theologians.

The theologians of Alexandria were greatly exercised over the immanence of God in the world. They considered the general question, how the primordial Being, who is the source of the inevitable recurrence of the world towards order, shares his nature with the world. In some sense he is a component in the natures of all fugitive things. Thus, an understanding of the nature of temporal things involves a comprehension of the immanence of the Eternal Being. This doctrine effects an important reconciliation between the doctrines of Imposed Law and Immanent Law. For, with this doctrine, the necessity of the trend towards order does not arise from the imposed will of a transcendent God. It arises from the fact, that the existents in nature are sharing in the nature of the immanent God.

This doctrine, in any clear form, is not Platonic, though it is a natural modification from Plato's own doctrine. But in the *Timaeus,* Plato provides a soul of this world who definitely is not the ultimate creator. By this notion, Plato prepared the way for the Gnostics with their fantastic machinery of emanations, and for the Arians. In the *Timaeus* the doctrine can be read as an allegory. In that case it was Plato's most unfortunate essay in mythology. The World-Soul, as an emanation, has been the parent of puerile metaphysics, which only

obscures the ultimate question of the relation of reality as permanent with reality as fluent: the mediator must be a component in common, and not a transcendent emanation.

The Western doctrine of Grace, derived from St. Augustine, leans heavily towards the notion of a wholly transcendent God imposing his partial favours on the world. Indeed, Calvin's rigid version of the same doctrine suggests the Manichean doctrine of a wholly evil material world partially rescued by God's arbitrary selection. For Calvinistic thought the physical order of the world was an arbitrary imposition of God's will. Indeed the Augustinian doctrine takes on diverse aspects according as it is derived from the will of a transcendent God, or the nature of an immanent God.

This unquestioned belief in order, with this chequered history,—Plato and Epicurus, the Gnostics, the Alexandrian theologians, the rationalists of Antioch and Mopsuetia, the Manicheans, Augustine, Calvin,—finally started the first phase of the modern world in the sixteenth century with the unquestioning presupposition that there is an order of nature which lies open in every detail to human understanding.

This belief can be traced back to the initiation of Plato and the Jewish prophets. But, in all probability, it is more than any of them clearly formulated or consistently believed. Lucretius gives the clearest formulation of the doctrine of an exact detailed order of nature. But even he has to make everything depend upon swervings of atoms which take place 'at no fixed part of space and no fixed time.'

Section VII. The conclusion of the seventeenth century marks a new stabilization of cosmological doctrine for the next two hundred years. For the moment the extreme Positivistic doctrine was eliminated. But, curiously enough, the three great figures, Newton, Leibniz, Locke, then dominating the world of thought, gave three diverse interpretations of the Platonic and Lucretian problems.

Newton's position was the more useful as a justification of the methodology required for the state of science, then and in the immediate future. He held the most simple-minded version of the Lucretian doctrine of the Void, the most simple-minded version of the Lucretian doctrine of material atoms, and the most simple-minded version of Law imposed by Divine decree. His only approach to any metaphysical penetration arises from his way of connecting the Void with the Sensorium of the Divine Nature. His cosmology is very easy

to understand and very hard to believe. Pragmatically it experienced a supreme justification, for two centuries. Thus its truth was pragmatically established, for the same period. His doctrine will stand for all time as a clear and distinct system of ideas, with large applications. Any cosmology must be capable of interpreting this system and of expressing its limitations.

The monads of Leibniz constitute another version of an atomic doctrine of the universe. It is true that Newton adopted without question some of the main positions of the Cartesian physics. But Newton was entirely innocent of the subjectivist bias of thought introduced by Descartes. Newton found himself knowing a lot of things, as interpreted in Cartesian fashion; and he successfully introduced a systematization of this knowledge, thus interpreted. But Descartes, before he attacked the problem of physics, asked the momentous questions,—How do I know, and How can I divest my knowledge of doubtful interpretation? The final issue of this subjective train of thought after a century of philosophizing is given by Hume's mental atomism, already mentioned in this chapter.

Leibniz was acutely conscious of this problem of the criticism of knowledge. Thus he approached the problem of cosmology from the subjective side, whereas Lucretius and Newton approach it from the objective point of view. They implicitly ask the question, What does the world of atoms look like to an intellect surveying it? What would such an intellect say about the spectacle of an atomic universe? The answer is contained in the Epic of Lucretius and the *Principia* of Newton, immortal works.

But Leibniz answered another question. He explained what it must be like to be an atom. Lucretius tells us what an atom looks like to others, and Leibniz tells us how an atom is feeling about itself. In this account Leibniz wrestles with a difficulty which infects modern cosmologies, a difficulty which Plato, Aristotle, Lucretius, and Newton entirely ignore—perhaps because they would have declared it to be founded upon a mistake. Descartes, as is usual with the founders of new schools of thought, exactly balanced himself between the old way and the new way of which he was the founder. The modern outlook arises from the slow influence of Aristotle's Logic, during a period of two thousand years. Also Aristotle's Logic is founded upon an analysis of the simplest form of a verbal sentence. For example, the sentence 'This water is hot' attributes the character

of high temperature to the particular mass of water in the particular bathtub. The quality of 'being hot' is an abstraction. Many different things can be hot, and we can think of being hot without thinking of any particular thing in a bathtub which is hot. But in the real physical world, the quality of 'being hot' can only appear as a characteristic of concrete things which *are* hot.

Again, still keeping to the point of view derived from Aristotelian Logic, if we ask for a complete account of a real particular thing in the physical world, the adequate answer is expressed in terms of a set of these abstract characteristics, which are united into an individualized togetherness which is the real thing in question.

This answer is beautifully simple. But it entirely leaves out of account the interconnections between real things. Each substantial thing is thus conceived as complete in itself, without any reference to any other substantial thing. Such an account of the ultimate atoms, or of the ultimate monads, or of the ultimate subjects enjoying experience, renders an interconnected world of real individuals unintelligible. The universe is shivered into a multitude of disconnected substantial things, each thing in its own way exemplifying its private bundle of abstract characters which have found a common home in its own substantial individuality. But substantial thing cannot call unto substantial thing. A substantial thing can acquire a quality, a credit—but real landed estate, never. In this way, Aristotle's doctrines of Predication and of Primary Substance have issued into a doctrine of the conjunction of attributes and of the disjunction of primary substances.

All modern epistemologies, all modern cosmologies, wrestle with this problem. There is, for their doctrine, a mysterious reality in the background, intrinsically unknowable by any direct intercourse. In the foreground of direct enjoyment, there is the play and interplay of various qualities diversifying the surface of the substantial unity of the solitary individual in question.

But one characteristic of each experiencing subject is a mysterious impulse to interpret its private world of enjoyed qualifications as indicating and symbolically defining a complex of communication between ultimate realities. Yet, according to the doctrine of these modern cosmologies, the how, or the why, of such communication must for ever lie beyond reason: for reason can only discern the set of qualities constituting the nature of an individual substance.

Such has been the long slow influence of Aristotelian Logic upon cosmological theory. Leibniz was the first, and by far the greatest philosopher, who both accepted the modern doctrine and frankly faced its difficulty. He boldly excepted God from the scope of the doctrine. God and each individual monad were in communication. Thus there is, on his doctrine, an indirect communication between monads by the mediation of God. But each monad independently develops its own experience according to its character which is imposed on it aboriginally by communication with God. This Leibnizian doctrine of Law by pre-established harmony is an extreme example of the doctrine of imposition, capable in some ways of being mitigated by the notion of the immanence of God. But no reason can be given why the supreme monad, God, is exempted from the common fate of isolation. Monads, according to this doctrine, are windowless for each other. Why have they windows towards God, and Why has God windows towards them?

It is interesting to enquire how the ancient cosmologists—Plato and Lucretius—evaded this difficulty.

In the first place it must be acknowledged that in Plato's *Dialogues* many unguarded statements, and many trains of thought, can be found which in themselves would lead straight to the modern difficulty. In fact, in this respect Aristotle's Logic can be found in germ in Plato. But in the ancient cosmologies, including Aristotle's own doctrine of matter, another train of thought can be found, which is in fact an emphatic doctrine of real communication. Plato's doctrine of the real Receptacle [ὑποδοχή and χώρα], and Epicurus' doctrine of the real Void [τό κενόν], differ in some details. But both doctrines are emphatic assertions of a real communication between ultimate realities. This communication is not accidental. It is part of the essential nature of each physical actuality that it is itself an element qualifying the Receptacle, and that the qualifications of the Receptacle enter into its own nature. In itself, with the various actualities abstracted from it, the Receptacle participates in no forms, according to Plato. But he designates it as 'the fostermother of all becoming.' Later in the same Dialogue he calls it 'a natural matrix for all things.' It receives its forms by reason of its inclusion of actualities, and in a way not to be abstracted from those actualities. The Receptacle, as discussed in the *Timaeus,* is the way in which Plato conceived the many actualities of the physical world as components in each other's na-

tures. It is the doctrine of the immanence of Law, derived from the mutual immanence of actualities. It is Plato's doctrine of the medium of intercommunication.*

Thus finally we can understand that the Receptacle, according to Plato, the Void, according to Lucretius, and God, according to Leibniz, play the same part in cosmological theory. Also in his general scholium, Newton definitely connects the Lucretian Void with the Leibnizian God. For he calls Empty space the 'sensorium of God.' We have here a formidable display of men of diverse genius, Plato and Aristotle, Epicurus and Lucretius, Newton and Leibniz. The modern cosmologies are all detailed variations of the great types which we have discussed. They revolve round the diverse notions of Law, the diverse notions of the communication between real individuals, the diverse notions of the mediating basis in virtue of which such communication is attained. One other problem, derivative from these general principles, but of major importance for human life is the doctrine of the status of the spirit of man in the scheme of things.

This more special problem of cosmological theory was the theme of the former part of this book. Its important influence upon the course of human history was illustrated. But it must not be thought that the more general problem of cosmology lies outside the scope of practical interest. The directions of human activities in various epochs, and the clashings of such directions in the same epoch, are the outcome of rough and ready solutions of the problem of cosmology, popularized throughout masses of mankind. Millions of men have marched to battle fiercely nerved by intense faith in Law imposed by the will of inflexible Allah, Law sharing out to each human his inevitable fate, Law sharing out to each faithful Mahometan either victory, or death and Paradise. Millions of Buddhists have shunned the intrinsic evils of such fierce Mahometan emotion relying on the impersonal immanence of Law, made clear to them by the doctrines of the Buddha. Millions of humans have shaped their lives

* On this topic, it is interesting to note the extreme difficulty of determining, whether or no Descartes held to the doctrine of *one* individual corporeal substance with many modal diversities of motion, or to the doctrine of *many* diverse individual corporeal substances essentially connected by extensive relations. Almost all his phrases are ambiguous on this point, with the exception of Principle LX, Part I, of his *Principles of Philosophy*. Here he unambiguously speaks of *every corporeal substance*, thus—at least in this place—deciding for a multiplicity of such substances. Either alternative leads him into difficulties.

according to the compromise between these two doctrines due to the Platonism of Christianity.

Finally, the restless modern search for increased accuracy of observation and for increased detailed explanation is based upon unquestioning faith in the reign of Law. Apart from such faith, the enterprise of science is foolish, hopeless.

SECTION VIII. The most recent of the four doctrines of the Laws of Nature still remains for discussion—The Doctrine of Conventional Interpretation. This doctrine certainly expresses the procedure by which free speculation passes into an interpretation of Nature. We elaborate a system of ideas, in detachment from any direct, detailed observation of matter of fact. For example, such detachment from detailed observation seems, on the surface, to be characteristic of Plato's *Dialogues*. They do not bear the aspect of patient induction from the facts. They are dominated by speculation and dialectics. Also Mathematics has developed, especially in recent years, by a speculative interest in types of order, without any determination of particular entities illustrative of those types. But Nature has subsequently been interpreted in terms of such mathematical laws. The conclusion seems to be, that Nature is patient of interpretation in terms of Laws which happen to interest us.

Yet another consideration supports this point of view. There is an element of arbitrary choice in our interpretation of the geometrical character of the physical world. Mathematicians have proved that any region which exemplifies metrical geometry of the Euclidean type, also exemplifies metrical geometry of the Elliptic type, and also metrical geometry of the Hyperbolic type. Further, if we start with any one of the three types, we can prove that both the remaining types are severally exemplified in the same subject-matter.

But it is an entire misconception, which has been entertained even by some mathematicians, to deduce that this mathematical truth has any bearing upon the notion of the Laws of Nature as arbitrary convention. For in the three metrical geometries as applying to the same subject-matter, the definitions of distance are different. Thus mathematicians have proved that if there be a metrical geometry of the Euclidean type, then with another definition of distance, and hence with another definition of congruence, there is a metrical geometry of the elliptic type also applying to the same subject-matter. There are three diverse systems of relationship within the subject-matter, so

related that if one be present then the others are present. Also, of course, the description of one set of relationships can be achieved, though very clumsily, in terms of any one of the other two sets. There is nothing 'conventional' in this, except the obvious fact that we can direct attention to any selected group of facts. Of course the question remains, What set of geometrical relationships are we referring to, when we say that we have walked thirty miles and are tired? Are they thirty Euclidean miles, or thirty Elliptic miles, or thirty Hyperbolic miles? Here the standard of reference can be the same in both cases, namely, the interval between two assigned marks fixed securely in Washington, D. C.

Again there is yet another geometrical ambiguity. For keeping to the same type of geometry—Euclidean, say, but either of the other two would serve equally well—keeping to Euclidean geometry, there are an infinite number of different alternative ways of defining distance so as to produce alternative systems of Euclidean geometry. Thus granting that one Euclidean system holds, an infinite number of other Euclidean systems also hold. Thus when a friend says that he has motored a hundred miles to see us, we should enquire what particular geometrical system of metrics he has adopted. And he has not settled the question by merely answering Euclidean. Also the differences are not necessarily slight. A thousand miles between particular towns on one system may be two miles on another system. It follows that every legislature should anxiously settle the metric system that it means to adopt. This question has nothing to do with the difference between miles and kilometers, or with mere imperfections of measurement. That is a much slighter point.

It is fairly obvious that, apart from minor inaccuracies of perception, we all do in fact adopt the same system. It is a fact of nature that a distance of thirty miles is a long walk for any one. There is no convention about that. Thus the appeal to geometry can be dismissed when we are discussing the question of the conventionality of the Laws of Nature.

Section IX. But the analogy of Geometry suggests an important reflection. It is well-known that Geometry can be developed without any reference to measurement,—and thus without any reference to distance, and without any reference to numerical coördinates for the indication of points. Geometry, developed in this fashion has been termed 'Non-metrical Projective Geometry.' Elsewhere * I have

* *The Axioms of Projective Geometry,* Cambridge Tracts in Mathematics, No. 4, Cambridge University Press, 1906. The reference is to Chapter I, Sec. 3.

termed it, 'the science of cross-classification.' Aristotle's science of classification into genera, and species, and sub-species, is the science of mutually exclusive classification. It develops Plato's suggestion of a science of 'Division.'

Projective Geometry is only one example of a science of cross-classification. Other such sciences have not been developed, partly because no obvious applications have obtruded themselves, and partly because the abstract interest of such sciences has not engaged the interest of any large group of mathematicians. For example, in *Principia Mathematica,** Section 93, 'On the Inductive Analysis of the Field of a Relation,' is a suggestion for another science of that type. Indeed the whole of Vol. I is devoted to the initiation of non-numerical quasi-geometrical sciences, together with a technique for their elaboration. The subsequent parts of the book specialize on those more special mathematical sciences which involve number and quantity.

This reference to *Principia Mathematica* has been made to remind ourselves that numerical relations derived from measurements constitute the subject-matter of a very special development of mathematics. This development has as yet constituted the only really important part of mathematics, except for the impressive disclosure of the extent to which ordinary Geometry is independent of measurement and number.

It follows that there are an indefinite number of purely abstract sciences, with their laws, their regularities, and their complexities of theorems—all as yet undeveloped. We can hardly avoid the conclusion that Nature in her procedures illustrates many such sciences. We are blind to such illustration because we are ignorant of the type of regularities to look for. In such cases, we may dimly sense a sort of familiarity attached to novel circumstances, without any notion how to proceed in the analysis of the vague feeling.

There is thus a certain amount of convention as to the emergence into human consciousness of sorts of Laws of Natures. The order of emergence depends upon the abstract sciences which civilized mankind have in fact chosen to develop.

But such 'convention' should not be twisted to mean that any facts of nature can be interpreted as illustrating any laws that we like to assign.

Section X. This discussion of the possible variety of types of

* Cambridge University Press, 1910.

Laws of Nature draws attention to a three-fold distinction which it is important to keep in mind during philosophic discussion. There are: (i) our direct intuitions which we enjoy prior to all verbalization: (ii) our literary modes of verbal expression of such intuitions, together with the dialectic deductions from such verbal formulæ: (iii) the set of purely deductive sciences, which have been developed so that the network of possible relations with which they deal are familiar in civilized consciousness.

The sciences under the heading (iii) direct attention for the exploration of the recesses of experience, and also assist in providing the verbal formulæ belonging to the heading (ii). The chief danger in philosophy is that the dialectic deductions from inadequate formulæ should exclude direct intuitions from explicit attentions. In fact the abstract sciences tend to correct the evil effects of the inadequacy of language, and the consequent dangers of a logic which presupposes linguistic adequacy.

Part III Philosophical

CHAPTER XI *OBJECTS AND SUBJECTS*

. . . Τό παρὸν ἑκάστῳ πὰθος, ἐξ ὧν αἱ αἰσθήσεις καὶ αἱ κατὰ ναύτας δόξαι γίγνονται, . . . *Theatetus,* 179 C.

§1. *Prefatory.*—When Descartes, Locke, and Hume undertake the analysis of experience, they utilize those elements in their own experience which lie clear and distinct, fit for the exactitude of intellectual discourse. It is tacitly assumed, except by Plato, that the more fundamental factors will ever lend themselves for discrimination with peculiar clarity. This assumption is here directly challenged.

§2. *Structure of Experience.*—No topic has suffered more from this tendency of philosophers than their account of the object-subject structure of experience. In the first place, this structure has been identified with the bare relation of knower to known. The subject is the knower, the object is the known. Thus, with this interpretation, the object-subject relation is the known-knower relation. It then follows that the more clearly any instance of this relation stands out for discrimination, the more safely we can utilize it for the interpreta-

tion of the status of experience in the universe of things. Hence Descartes' appeal to clarity and distinctness.

This deduction presupposes that the subject-object relation is the fundamental structural pattern of experience. I agree with this presupposition, but not in the sense in which subject-object is identified with knower-known. I contend that the notion of mere knowledge is a high abstraction, and that conscious discrimination itself is a variable factor only present in the more elaborate examples of occasions of experience. The basis of experience is emotional. Stated more generally, the basic fact is the rise of an affective tone originating from things whose relevance is given.

§3. *Phraseology.*—Thus the Quaker word 'concern,' divested of any suggestion of knowledge, is more fitted to express this fundamental structure. The occasion as subject has a 'concern' for the object. And the 'concern' at once places the object as a component in the experience of the subject, with an affective tone drawn from this object and directed towards it. With this interpretation the subject-object relation is the fundamental structure of experience.

Quaker usages of language are not widely spread. Also each phraseology leads to a crop of misunderstandings. The subject-object relation can be conceived as Recipient and Provoker, where the fact provoked is an affective tone about the status of the provoker in the provoked experience. Also the total provoked occasion is a totality involving many such examples of provocation. Again this phraseology is unfortunate; for the word 'recipient' suggests a passivity which is erroneous.

§4. *Prehensions.*—A more formal explanation is as follows. An occasion of experience is an activity, analysable into modes of functioning which jointly constitute its process of becoming. Each mode is analysable into the total experience as active subject, and into the thing or object with which the special activity is concerned. This thing is a datum, that is to say, is describable without reference to its entertainment in that occasion. An object is anything performing this function of a datum provoking some special activity of the occasion in question. Thus subject and object are relative terms. An occasion is a subject in respect to its special activity concerning an object; and anything is an object in respect to its provocation of some special activity within a subject. Such a mode of activity is termed a 'prehension.' Thus a prehension involves three factors. There is the occasion

of experience within which the prehension is a detail of activity; there is the datum whose relevance provokes the origination of this prehension; this datum is the prehended object; there is the subjective form, which is the affective tone determining the effectiveness of that prehension in that occasion of experience. How the experience constitutes itself depends on its complex of subjective forms.

§5. *Individuality.*—The individual immediacy of an occasion is the final unity of subjective form, which is the occasion as an absolute reality. This immediacy is its moment of sheer individuality, bounded on either side by essential relativity. The occasion arises from relevant objects, and perishes into the status of an object for other occasions. But it enjoys its decisive moment of absolute self-attainment as emotional unity. As used here the words 'individual' and 'atom' have the same meaning, that they apply to composite things with an absolute reality which their components lack. These words properly apply to an actual entity in its immediacy of self-attainment when it stands out as for itself alone, with its own affective self-enjoyment. The term 'monad' also expresses this essential unity at the decisive moment, which stands between its birth and its perishing. The creativity of the world is the throbbing emotion of the past hurling itself into a new transcendent fact. It is the flying dart, of which Lucretius speaks, hurled beyond the bounds of the world.

§6. *Knowledge.*—All knowledge is conscious discrimination of objects experienced. But this conscious discrimination, which is knowledge, is nothing more than an additional factor in the subjective form of the interplay of subject with object. This interplay is the stuff constituting those individual things which make up the sole reality of the Universe. These individual things are the individual occasions of experience, the actual entities.

But we do not so easily get rid of knowledge. After all, it is knowledge that philosophers seek. And all knowledge is derived from, and verified by, direct intuitive observation. I accept this axiom of empiricism as stated in this general form. The question then arises how the structure of experience outlined above is directly observed. In answering this challenge I remind myself of the old advice that the doctrines which best repay critical examination are those which for the longest period have remained unquestioned.

§7. *Sense-Perception.*—The particular agelong group of doctrines which I have in mind is: (1) that all perception is by the mediation

of our bodily sense-organs, such as eyes, palates, noses, ears, and the diffused bodily organization furnishing touches, aches, and other bodily sensations; (2) that all percepta are bare sensa, in patterned connections, given in the immediate present; (3) that our experience of a social world is an interpretative reaction wholly derivative from this perception; (4) that our emotional and purposive experience is a reflective reaction derived from the original perception, and intertwined with the interpretative reaction and partly shaping it. Thus the two reactions are different aspects of one process, involving interpretative, emotional, and purposive factors. Of course, we are all aware that there are powerful schools of philosophy which explicitly reject this doctrine. Yet I cannot persuade myself that this rejection has been taken seriously by writers belonging to the schools in question. When the direct question as to things perceived arises, it seems to me that the answer is always returned in terms of sensa perceived.

§8. *Perceptive Functions.*—In the examination of the sensationalist doctrine, the first question to be asked concerns the general definition of what we mean by those functions of experience which we term 'perceptions.' If we define them as those experiential functions which arise directly from the stimulation of the various bodily sense-organs, then argument ceases. The traditional doctrine then becomes a mere matter of definition of the use of the word 'perception.' Indeed, having regard to long-standing usage, I am inclined to agree that it may be advisable for philosophers to confine the word 'perception' to this limited meaning. But the point on which I am insisting is that this meaning *is* limited, and that there is a wider meaning with which this limited use of the term 'perception' has been tacitly identified.

§9. *Objects.*—The process of experiencing is constituted by the reception of entities, whose being is antecedent to that process, into the complex fact which is that process itself. These antecedent entities, thus received as factors into the process of experiencing, are termed 'objects' for that experiential occasion. Thus primarily the term 'object' expresses the relation of the entity, thus denoted, to one or more occasions of experiencing. Two conditions must be fulfilled in order that an entity may function as an object in a process of experiencing: (1) the entity must be *antecedent,* and (2) the entity must be experienced in virtue of its antecedence; it must be

given. Thus an object must be a thing received, and must not be either a *mode* of reception or a thing *generated* in that occasion. Thus the process of experiencing is constituted by the reception of objects into the unity of that complex occasion which is the process itself. The process creates itself, but it does not create the objects which it receives as factors in its own nature.

'Objects' for an occasion can also be termed the 'data' for that occasion. The choice of terms entirely depends on the metaphor which you prefer. One word carries the literal meaning of 'lying in the way of,' and the other word carries the literal meaning of 'being given to.' But both words suffer from the defect of suggesting that an occasion of experiencing arises out of a passive situation which is a mere welter of many data.

§10. *Creativity.*—The exact contrary is the case. The initial situation includes a factor of activity which is the reason for the origin of that occasion of experience. This factor of activity is what I have called 'Creativity.' The initial situation with its creativity can be termed the initial phase of the new occasion. It can equally well be termed the 'actual world' relative to that occasion. It has a certain unity of its own, expressive of its capacity for providing the objects requisite for a new occasion, and also expressive of its conjoint activity whereby it is essentially the primary phase of a new occasion. It can thus be termed a 'real potentiality.' The 'potentiality' refers to the passive capacity, the term 'real' refers to the creative activity, where the Platonic definition of 'real' in the *Sophist* is referred to. This basic situation, this actual world, this primary phase, this real potentiality—however you characterize it—as a whole is active with its inherent creativity, but in its details it provides the passive objects which derive their activity from the creativity of the whole. The creativity is the actualization of potentiality, and the process of actualization is an occasion of experiencing. Thus viewed in abstraction objects are passive, but viewed in conjunction they carry the creativity which drives the world. The process of creation is the form of unity of the Universe.

§11. *Perception.*—In the preceding sections, the discovery of objects as factors in experience was explained. The discussion was phrased in terms of an ontology which goes beyond the immediate purpose, although the status of objects cannot be understood in the absence of some such ontology explaining their function in experi-

ence, that is to say, explaining why an occasion of experience by reason of its nature requires objects.

The objects are the factors in experience which function so as to express that that occasion originates by including a transcendent universe of other things. Thus it belongs to the essence of each occasion of experience that it is concerned with an otherness transcending itself. The occasion is one among others, and including the others which it is among. Consciousness is an emphasis upon a selection of these objects. Thus perception is consciousness analysed in respect to those objects selected for this emphasis. Consciousness is the acme of emphasis.

It is evident that this definition of perception is wider than the narrow definition based upon sense-perception, sensa, and the bodily sense-organs.

§12. *Non-Sensuous Perception.*—This wider definition of perception can be of no importance unless we can detect occasions of experience exhibiting modes of functioning which fall within its wider scope. If we discover such instances of non-sensuous perception, then the tacit identification of perception with sense-perception must be a fatal error barring the advance of systematic metaphysics.

Our first step must involve the clear recognition of the limitations inherent in the scope of sense-perception. This special mode of functioning essentially exhibits percepta as *here, now, immediate,* and *discrete.* Every impression of sensation is a distinct existence, declares Hume; and there can be no reasonable doubt of this doctrine. But even Hume clothes each impression with force and liveliness. It must be distinctly understood that no prehension, even of bare sensa, can be divested of its affective tone, that is to say, of its character of a 'concern' in the Quaker sense. Concernedness is of the essence of perception.

Gaze at a patch of red. In itself as an object, and apart from other factors of concern, this patch of red, as the mere object of that present act of perception, is silent as to the past or the future. How it originates, how it will vanish, whether indeed there was a past, and whether there will be a future, are not disclosed by its own nature. No material for the interpretation of sensa is provided by the sensa themselves, as they stand starkly, barely, present and immediate. We *do* interpret them; but no thanks for the feat is due to them. The epistemologies of the last two hundred years are employed in the

tacit introduction of alien considerations by the uncritical use of current forms of speech. A copious use of simple literary forms can thus provide a philosophy delightful to read, easy to understand, and entirely fallacious. Yet the usages of language do prove that our habitual interpretations of these barren sensa are in the main satisfying to common sense, though in particular instances liable to error. But the evidence on which these interpretations are based is entirely drawn from the vast background and foreground of non-sensuous perception with which sense-perception is fused, and without which it can never be. We can discern no clean-cut sense-perception wholly concerned with present fact.

In human experience, the most compelling example of non-sensuous perception is our knowledge of our own immediate past. I am not referring to our memories of a day past, or of an hour past, or of a minute past. Such memories are blurred and confused by the intervening occasions of our personal existence. But our immediate past is constituted by that occasion, or by that group of fused occasions, which enters into experience devoid of any perceptible medium intervening between it and the present immediate fact. Roughly speaking, it is that portion of our past lying between a tenth of a second and half a second ago. It is gone, and yet it is here. It is our indubitable self, the foundation of our present existence. Yet the present occasion while claiming self-identity, while sharing the very nature of the byegone occasion in all its living activities, nevertheless is engaged in modifying it, in adjusting it to *other* influences, in completing it with *other* values, in deflecting it to *other* purposes. The present moment is constituted by the influx of *the other* into that self-identity which is the continued life of the immediate past within the immediacy of the present.

§13. *Illustration.*—Consider a reasonably rapid speaker enunciating the proper name 'United States'. There are four syllables here. When the third syllable is reached, probably the first is in the immediate past; and certainly during the word 'States' the first syllable of the phrase lies beyond the immediacy of the present. Consider the speaker's own occasions of existence. Each occasion achieves for him the immediate sense-presentation of sounds, the earlier syllables in the earlier occasions, the word 'States' in the final occasion. As mere sensuous perception, Hume is right in saying that the sound 'United' as a mere sensum has nothing in its nature referent to the

sound 'States', yet the speaker is carried from 'United' to 'States', and the two conjointly live in the present, by the energizing of the past occasion as it claims its self-identical existence as a living issue in the present. The immediate past as surviving to be again lived through in the present is the palmary instance of non-sensuous perception.

The Humian explanation, involving the 'association of ideas', has its importance for this topic. But it is not to the point for this example. The speaker, a citizen of the United States and therefore dominated by an immense familiarity with that phrase, may in fact have been enunciating the phrase 'United Fruit Company'—a corporation which, for all its importance, he may not have heard of till half a minute earlier. In his experience the relation of the later to the earlier parts of this phrase is entirely the same as that described above for the phrase 'United States.' In this latter example it is to be noted that while association would have led him to 'States', the fact of the energizing of the immediate past compelled him to conjoin 'Fruit' in the immediacy of the present. He uttered the word 'United' with the non-sensuous anticipation of an immediate future with the sensum 'Fruit', and he then uttered the word 'Fruit' with the non-sensuous perception of the immediate past with the sensum 'United'. But, unfamiliar as he was with the United Fruit Company, he had no association connecting the various words in the phrase 'United Fruit Company'; while, patriot as he was, the orator had the strongest association connecting the words 'United' and 'States'. Perhaps, indeed, he was the founder of the Company, and also invented the name. He then uttered the mere sounds 'United Fruit Company' for the first time in the history of the English language. There could not have been the vestige of an association to help him along. The final occasion of his experience which drove his body to the utterance of the sound 'Company' is only explicable by his concern with the earlier occasions with their subjective forms of intention to procure the utterance of the complete phrase. Also, in so far as there was consciousness, there was direct observation of the past with its intention finding its completion in the present fact. This is an instance of direct intuitive observation which is incapable of reduction to the sensationalist formula. Such observations have not the clear sharp-cut precision of sense-perception. But surely there can be no doubt about them. For instance, if the speaker had been interrupted after the words 'United

Fruit', he might have resumed his speech with the words 'I meant to add the word Company'. Thus during the interruption, the past was energizing in his experience as carrying in itself an unfulfilled intention.

§14. *Conformation of Feeling.*—Another point emerges in this explanation, namely, the doctrine of the continuity of nature. This doctrine balances and limits the doctrine of the absolute individuality of each occasion of experience. There is a continuity between the subjective form of the immediate past occasion and the subjective form of its primary prehension in the origination of the new occasion. In the process of synthesis of the many basic prehensions modifications enter. But the subjective forms of the immediate past are continuous with those of the present. I will term this doctrine of continuity, the Doctrine of Conformation of Feeling.

Suppose that for some period of time some circumstance of his life has aroused anger in a man. How does he now know that a quarter of a second ago he was angry? Of course, he remembers it; we all know that. But I am enquiring about this very curious fact of memory, and have chosen an overwhelmingly vivid instance. The mere word 'memory' explains nothing. The first phase in the immediacy of the new occasion is that of the conformation of feelings. The feeling as enjoyed by the past occasion is present in the new occasion as datum felt, with a subjective form conformal to that of the datum. Thus if A be the past occasion, D the datum felt by A with subjective form describable as A angry, then this feeling—namely, A feeling D with subjective form of anger—is initially felt by the new occasion B with the same subjective form of anger. The anger is continuous throughout the successive occasions of experience. This continuity of subjective form is the initial sympathy of B for A. It is the primary ground for the continuity of nature.

Let us elaborate the consideration of the angry man. His anger is the subjective form of his feeling some datum D. A quarter of a second later he is, consciously, or unconsciously, embodying his past as a datum in the present, and maintaining in the present the anger which is a datum from the past. In so far as that feeling has fallen within the illumination of consciousness, he enjoys a non-sensuous perception of the past emotion. He enjoys this emotion both objectively, as belonging to the past, and also formally as continued in the present. This continuation is the continuity of

nature. I have labored this point, because traditional doctrines involve its denial.

Thus non-sensuous perception is one aspect of the continuity of nature.

§15. *Hume's Doctrine of Custom.*—Hume appeals to a doctrine of force and liveliness as an essential factor in an impression of sensation. This doctrine is nothing but a special case of the doctrine of subjective forms. Again he holds that the force and liveliness of one occasion of experience enter into the character of succeeding occasions. The whole doctrine of 'custom' depends on this assumption. If the occasions be entirely separate, as Hume contends, this transition of character is without any basis in the nature of things. What Hume, in his appeal to memory, is really doing is to appeal to an observed immanence of the past in the future, involving a continuity of subjective form.

With this addition, every argument of Part III of Hume's *Treatise* can be accepted. But the conclusion follows that there is an observed relation of causation between such occasions. The general character of this observed relation explains at once memory and personal identity. They are all different aspects of the doctrine of the immanence of occasions of experience. The additional conclusion can also be derived, that in so far as we apply notions of causation to the understanding of events in nature, we must conceive these events under the general notions which apply to occasions of experience. For we can only understand causation in terms of our observations of these occasions. This appeal to Hume has the sole purpose of illustrating the common-sense obviousness of the present thesis.

§16. *The Flux of Energy.*—An occasion of experience which includes a human mentality is an extreme instance, at one end of the scale, of those happenings which constitute nature. As yet this discussion has fixed attention upon this extreme. But any doctrine which refuses to place human experience outside nature, must find in descriptions of human experience factors which also enter into the descriptions of less specialized natural occurrences. If there be no such factors, then the doctrine of human experience as a fact within nature is mere bluff, founded upon vague phrases whose sole merit is a comforting familiarity. We should either admit dualism, at least as a provisional doctrine, or we should point out the identical elements connecting human experience with physical science.

The science of physics conceives a natural occasion as a locus of energy. Whatever else that occasion may be, it is an individual fact harboring that energy. The words electron, proton, photon, wave-motion, velocity, hard and soft radiation, chemical elements, matter, empty space, temperature, degradation of energy, all point to the fact that physical science recognizes qualitative differences between occasions in respect to the way in which each occasion entertains its energy.

These differences are entirely constituted by the flux of energy, that is to say, by the way in which the occasions in question have inherited their energy from the past of nature, and in which they are about to transmit their energy to the future. The discussion of the Poynting Flux of Energy is one of the most fascinating chapters of Electrodynamics. Forty-seven years ago, when a young graduate student, I first heard of it in a lecture delivered by Sir J. J. Thomson. It was then a new discovery recently published by Poynting. But its father was the great Clerk-Maxwell who had expounded all the requisite principles. The sole conclusion with which we are concerned is that energy has recognizable paths through time and space. Energy passes from particular occasion to particular occasion. At each point there is a flux, with a quantitative flow and a definite direction.

This is a conception of physical nature in terms of continuity. In fact, the concept of continuity was dominant in Clerk-Maxwell's thought. But the alternative concept of distinguishable individualities has again emerged into importance in the more recent physics. Electrons and protons and photons are unit charges of electricity; also there are the quanta of the flux of energy. These contrasted aspects of nature, continuity and atomicity, have a long history in European thought, reaching back to the origin of science among the Greeks. The more probable conclusion is that neither can be dispensed with, and that we are only witnessing that modern phase of the contrast which is relevant to the present stage of science.

§17. *Mind and Nature Compared.*—The doctrine of human experience which I have outlined above, also for its own purposes preserves a doctrine of distinguishable individualities which are the separate occasions of experience, and a doctrine of continuity expressed by the identity of subjective form inherited conformally from one occasion to the other. The physical flux corresponds to the

conformal inheritance at the base of each occasion of experience. This inheritance, in spite of its continuity of subjective form, is nevertheless an inheritance from definite individual occasions. Thus, if the analogy is to hold, in the account of the general system of relations binding the past to the present, we should expect a doctrine of quanta, where the individualities of the occasions are relevant, and a doctrine of continuity where the conformal transference of subjective form is the dominating fact.

The notion of physical energy, which is at the base of physics, must then be conceived as an abstraction from the complex energy, emotional and purposeful, inherent in the subjective form of the final synthesis in which each occasion completes itself. It is the total vigor of each activity of experience. The mere phrase that 'physical science is an abstraction', is a confession of philosophic failure. It is the business of rational thought to describe the more concrete fact from which that abstraction is derivable.

§18. *Personality.*—In our account of human experience we have attenuated human personality into a genetic relation between occasions of human experience. Yet personal unity is an inescapable fact. The Platonic and Christian doctrines of the Soul, the Epicurean doctrine of a Concilium of subtle atoms, the Cartesian doctrine of Thinking Substance, the Humanitarian doctrine of the Rights of man, the general Common Sense of civilized mankind,—these doctrines between them dominate the whole span of Western thought. Evidently there is a fact to be accounted for. Any philosophy must provide some doctrine of personal identity. In some sense there is a unity in the life of each man, from birth to death. The two modern philosophers who most consistently reject the notion of a self-identical Soul-Substance are Hume and William James. But the problem remains for them, as it does for the philosophy of organism, to provide an adequate account of this undoubted personal unity, maintaining itself amidst the welter of circumstance.

§19. *Plato's Receptacle.*—In mathematical studies, where there is a problem to be solved it is a sound method to generalize, so as to divest the problem of details irrelevant to the solution. Let us therefore give a general description of this personal unity, divesting it of minor details of humanity. For this purpose it is impossible to improve upon a passage from one of Plato's Dialogues. I summarize it with the insertion of such terms as 'personal unity', 'events', 'ex-

perience', and 'personal identity', for two or three of its own phrases:—'In addition to the notions of the welter of events and of the forms which they illustrate, we require a third term, personal unity. It is a perplexed and obscure concept. We must conceive it the receptacle, the foster-mother as I might say, of the becoming of our occasions of experience. This personal identity is the thing which receives all occasions of the man's existence. It is there as a natural matrix for all transitions of life, and is changed and variously figured by the things that enter it; so that it differs in its character at different times. Since it receives all manner of experiences into its own unity, it must itself be bare of all forms. We shall not be far wrong if we describe it as invisible, formless, and all-receptive. It is a locus which persists, and provides an emplacement for all the occasions of experience. That which happens in it is conditioned by the compulsion of its own past, and by the persuasion of its immanent ideals.'

You will have recognized that in this description I have been adapting from Plato's *Timaeus,** with the slightest of changes. But this is not Plato's description of the Soul. It is his doctrine of the Receptacle [ὑποδοχή] or Locus [χώρα] whose sole function is the imposition of a unity upon the events of Nature. These events are together by reason of their community of locus, and they obtain their actuality by reason of emplacement within this community.

§20. *Immanence.*—This is at once the doctrine of the unity of nature, and of the unity of each human life. The conclusion follows that our consciousness of the self-identity pervading our life-thread of occasions, is nothing other than knowledge of a special strand of unity within the general unity of nature. It is a locus within the whole, marked out by its own peculiarities, but otherwise exhibiting the general principle which guides the constitution of the whole. This general principle is the object-to-subject structure of experience. It can be otherwise stated as the vector-structure of nature. Or otherwise, it can be conceived as the doctrine of the immanence of the past energizing in the present.

This doctrine of immanence is practically that doctrine adumbrated by the Hellenistic Christian theologians of Egypt. But they applied the doctrine only to the relation of God to the World, and not to all actualities.

* I have used A. E. Taylor's translation, with compression and changes of phrase.

§21. *Space and Time.*—The notion of Space-Time represents a compromise between Plato's basic Receptacle, imposing no forms, and the Actual World imposing its own variety of forms. This imposition of forms is subject to the perspective elimination required by incompatibilities of affective tone. Geometry is the doctrine of loci of intermediaries imposing perspective in the process of inheritance. In geometry this doctrine is restricted to its barest generalities of coördination prevailing for this epoch of the Universe. These generalities solely concern the complex of serial relations persistently illustrated in the connection of events.

Our perception of this geometrical order of the Universe brings with it the denial of the restriction of inheritance to mere personal order. For personal order means one-dimensional serial order. And space is many-dimensional. Spatiality involves separation by reason of the diversity of intermediate occasions, and also it involves connection by reason of the immanence involved in the derivation of present from past. There is thus an analogy between the transference of energy from particular occasion to particular occasion in physical nature and the transference of affective tone, with its emotional energy, from one occasion to another in any human personality. The object-to-subject structure of human experience is reproduced in physical nature by this vector relation of particular to particular. It was the defect of the Greek analysis of generation that it conceived it in terms of the bare incoming of novel abstract form. This ancient analysis failed to grasp the real operation of the antecedent particulars imposing themselves on the novel particular in process of creation. Thus the geometry exemplified in fact was disjoined from their account of the generation of fact.

§22. *The Human Body.*—But this analogy of physical nature to human experience is limited by the fact of the linear seriality of human occasions within any one personality and of the many-dimensional seriality of the occasions in physical Space-Time.

In order to prove that this discrepancy is only superficial, it now remains for discussion whether the human experience of direct inheritance provides any analogy to this many-dimensional character of space. If human occasions of experience essentially inherit in one-dimensional personal order, there is a gap between human occasions and the physical occasions of nature.

The peculiar status of the human body at once presents itself as

negating this notion of strict personal order for human inheritance. Our dominant inheritance from our immediately past occasion is broken into by innumerable inheritances through other avenues. Sensitive nerves, the functionings of our viscera, disturbances in the composition of our blood, break in upon the dominant line of inheritance. In this way, emotions, hopes, fears, inhibitions, sense-perceptions arise, which physiologists confidently ascribe to the bodily functionings. So intimately obvious is this bodily inheritance that common speech does not discriminate the human body from the human person. Soul and body are fused together. Also this common identification has survived the scientific investigation of physiologists, who are apt to see more body than soul in human beings.

But the human body is indubitably a complex of occasions which are part of spatial nature. It is a set of occasions miraculously coördinated so as to pour its inheritance into various regions within the brain. There is thus every reason to believe that our sense of unity with the body has the same original as our sense of unity with our immediate past of personal experience. It is another case of non-sensuous perception, only now devoid of the strict personal order.

But physiologists and physicists are equally agreed that the body inherits physical conditions from the physical environment according to the physical laws. There is thus a general continuity between human experience and physical occasions. The elaboration of such a continuity is one most obvious task for philosophy.

§23. *Dualism.*—This discussion has begged attention to a complex argument. I will conclude it by drawing attention to a general question which is relevant.

Is this discussion to be looked upon as another example of *The Revolt against Dualism?* We have all read with high appreciation Professor Lovejoy's brilliant book in criticism of this revolt. Now superficially the position which I have here put forward is certainly an instance of the revolt which he criticizes. But in another sense, I have endeavored to put forward a defence of dualism, differently interpreted. Plato, Descartes, Locke, prepared the way for Hume; and Kant followed upon Hume. The point of this discussion is to show an alternative line of thought which evades Hume's deduction from the philosophical tradition, and at the same time preserves the general trend of thought received from his three great predecessors. The dualism in the later Platonic dialogues between the

Platonic 'souls' and the Platonic 'physical' nature, the dualism between the Cartesian 'thinking substances' and the Cartesian 'extended substances', the dualism between the Lockian 'human understanding' and the Lockian 'external things' described for him by Galileo and Newton—all these kindred dualisms are here found within each occasion of actuality. Each occasion has its physical inheritance and its mental reaction which drives it on to its self-completion. The world is not merely physical, nor is it merely mental. Nor is it merely *one* with many subordinate phases. Nor is it merely a complete fact, in its essence static with the illusion of change. Wherever a vicious dualism appears, it is by reason of mistaking an abstraction for a final concrete fact.

The universe is dual because, in the fullest sense, it is both transient and eternal. The universe is dual because each final actuality is both physical and mental. The universe is dual because each actuality requires abstract character. The universe is dual because each occasion unites its formal immediacy with objective otherness. The universe is *many* because it is wholly and completely to be analysed into many final actualities—or in Cartesian language, into many *res verae*. The Universe is *one,* because of the universal immanence. There is thus a dualism in this contrast between the unity and multiplicity. Throughout the universe there reigns the union of opposites which is the ground of dualism.

CHAPTER XII *PAST, PRESENT, FUTURE*

SECTION I. The doctrine of the immanence of past occasions in the occasions which are future, relatively to them, has been sufficiently discussed in the previous chapter. The past has an objective existence in the present which lies in the future beyond itself. But the sense in which the future can be said to be immanent in occasions antecedent to itself, and the sense in which contemporary occasions are immanent in each other, are not so evident in terms of the doctrine of the subject-object structure of experience. It will be simpler first to concentrate upon the relation of the future to the present. It is evident that the future certainly is something for the present. The most famil-

iar habits of mankind witness to this fact. Legal contracts, social understandings of every type, ambitions, anxieties, railway time-tables, are futile gestures of consciousness apart from the fact that the present bears in its own realized constitution relationships to a future beyond itself. Cut away the future, and the present collapses, emptied of its proper content. Immediate existence requires the insertion of the future in the crannies of the present.

Here again the habits of a literary training with its long-range forecast and back-cast of critical thought exercise an unfortunate effect upon philosophy. We think of the future in time-spans of centuries, or of decades, or of years, or of days. We dwell critically upon the mass of fables termed history. As a result we conceive ourselves as related to past or to future by a mere effort of purely abstract imagination, devoid of direct observation of particular fact. If we admit this conclusion, there is no real evidence that there was a past, or that there will be a future. Our ignorance on this point is complete. All that we can observe consists of conceptual persuasions in the present. Such is the outcome of the literary habit of dwelling upon the long future or upon the long past. Literature preserves the wisdom of the human race; but in this way it enfeebles the emphasis of first-hand intuition. In considering our direct observation of past, or of future, we should confine ourselves to time-spans of the order of magnitude of a second, or even of fractions of a second.

Section II. If we keep ourselves to this short-range intuition, assuredly the future is not nothing. It lives actively in its antecedent world. Each moment of experience confesses itself to be a transition between two worlds, the immediate past and the immediate future. This is the persistent delivery of common-sense. Also this immediate future is immanent in the present with some degree of structural definition. The difficulty lies in the explanation of this immanence in terms of the subject-object structure of experience. In the present, the future occasions, as individual realities with their measure of absolute completeness, are non-existent. Thus the future must be immanent in the present in some different sense to the objective immortality of the individual occasions of the past. In the present there are no individual occasions belonging to the future. The present contains the utmost verge of such realized individuality. The whole doctrine of the future is to be understood in terms of the account of the process of self-completion of each individual actual occasion.

This process can be shortly characterized as a passage from re-

enaction to anticipation. The intermediate stage in this transition is constituted by the acquisition of novel content, which is the individual contribution of the immediate subject for the re-shaping of its primary phase of re-enaction into its final phase of anticipation. This final phase is otherwise termed the 'satisfaction,' since it marks the exhaustion of the creative urge for that individuality. This novel content is composed of positive conceptual prehensions, that is to say, of conceptual feelings. These conceptual feelings become integrated with the physical prehensions of antecedent occasions, and thus yield propositions concerning the past. These propositions are again integrated and re-integrated with each other and with conceptual feelings, and yield other propositions.

Finally propositions emerge concerning the constitution of the immediate subject. It belongs to the essence of this subject that it pass into objective immortality. Thus its own constitution involves that its own activity in *self*-formation passes into its activity of *other*-formation. It is by reason of the constitution of the present subject that the future will embody the present subject and will re-enact its patterns of activity. But the future individual occasions are non-existent. The sole immediate actuality is the constitution of the present subject which embodies its own necessity for objective immortality beyond its own immediacy of self-formation. This objective immortality is a stubborn fact for the future, involving its pattern of perspective re-enaction.

The final phase of anticipation is a propositional realization of the essence of the present-subject, in respect to the necessities which it lays upon the future to embody it and to re-enact it so far as compatibility may permit. Thus the self-enjoyment of an occasion of experience is initiated by an enjoyment of the past as alive in itself and is terminated by an enjoyment of itself as alive in the future. This is the account of the creative urge of the universe as it functions in each single individual occasion. In this sense, the future is immanent in each present occasion, with its particular relations to the present settled in various degrees of dominance. But no future individual occasion is in existence. The anticipatory propositions all concern the constitution of the present occasion and the necessities inherent in it. This constitution necessitates that there be a future, and necessitates a quota of contribution for re-enaction in the primary phases of future occasions.

The point to remember is that the fact that each individual occa-

sion is transcended by the creative urge, belongs to the essential constitution of each such occasion. It is not an accident which is irrelevant to the completed constitution of any such occasion.

In the formation of each occasion of actuality the swing over from re-enaction to anticipation is due to the intervening touch of mentality. Whether the ideas thus introduced by the novel conceptual prehensions be old or new, they have this decisive result, that the occasion arises as an effect facing its past and ends as a cause facing its future. In between there lies the teleology of the Universe.

If the mental activity involves no introduction of ideal novelty, the data of the conceptual feelings are merely eternal objects already illustrated in the initial phase of re-enaction. In that case, the reintegration with the primary phase merely converts the initial conformal reception into the anticipation of preservation of types of order and of patterns of feeling already dominant in the inheritance. There is a reign of acquiescence. In this way, a region of such occasions assumes the aspect of passive submission to imposed laws of nature. But when there is conceptual novelty made effective by its re-iteration and by the added emphasis on it throughout a chain of coördinated occasions, we have the aspect of an enduring person with a sustained purpose originated by that person and made effective in that person's environment. Thus in this case the anticipation of kinship with the future assumes the form of purpose to transform concept into fact. In either case, whether or no there be conceptual novelty, the subjective forms of the conceptual prehensions constitute the drive of the Universe, whereby each occasion precipitates itself into the future.

Section III. It is now possible to determine the sense in which the future is immanent in the present. The future is immanent in the present by reason of the fact that the present bears in its own essence the relationships which it will have to the future. It thereby includes in its essence the necessities to which the future must conform. The future is there in the present, as a general fact belonging to the nature of things. It is also there with such general determinations as it lies in the nature of the particular present to impose on the particular future which must succeed it. All this belongs to the essence of the present, and constitutes the future, as thus determined, an object for prehension in the subjective immediacy of the present. In this way each present occasion prehends the general metaphysical character of the universe, and thereby it prehends its own share in that

character. Thus the future is to the present as an object for a subject. It has an objective existence in the present. But the objective existence of the future in the present differs from the objective existence of the past in the present. The various particular occasions of the past are in existence, and are severally functioning as objects for prehension in the present. This individual objective existence of the actual occasions of the past, each functioning in each present occasion, constitutes the causal relationship which is efficient causation. But there are no actual occasions in the future, already constituted. Thus there are no actual occasions in the future to exercise efficient causation in the present. What is objective in the present is the necessity of a future of actual occasions, and the necessity that these future occasions conform to the conditions inherent in the essence of the present occasion. The future belongs to the essence of present fact, and has no actuality other than the actuality of present fact. But its particular relationships to present fact are already realized in the nature of present fact.

Section IV. It is the definition of contemporary events that they happen in causal independence of each other. Thus two contemporary occasions are such that neither belongs to the past of the other. The two occasions are not in any direct relation of efficient causation. The vast causal independence of contemporary occasions is the preservative of the elbow-room within the Universe. It provides each actuality with a welcome environment for irresponsibility. 'Am I my brother's keeper?' expresses one of the earliest gestures of self-consciousness. Our claim for freedom is rooted in our relationship to our contemporary environment. Nature does provide a field for independent activities. The understanding of the Universe requires that we conceive in their proper relations to each other the various rôles, of efficient causation, of teleological self-creation, and of contemporary independence. This adequate conception requires also understanding of perspective elimination, and of types of order dominating vast epochs, and of minor endurances with their own additional modes of order diversifying each larger epoch within which they find themselves.

The mutual independence of contemporary occasions lies strictly within the sphere of their teleological self-creation. The occasions originate from a common past and their objective immortality operates within a common future. Thus indirectly, *via* the immanence of

the past and the immanence of the future, the occasions are connected. But the immediate activity of self-creation is separate and private, so far as contemporaries are concerned.

There is thus a certain indirect immanence of contemporary occasions in each other. For if A and B be contemporaries, and C be in the past of both of them, then A and B are each in a sense immanent in C, in the way in which the future can be immanent in its past. But C is objectively immortal in both A and B. Thus, in this indirect sense, A is immanent in B, and B is immanent in A. But the objective immortality of A does not operate in B, nor does that of B operate in A. As individual complete actualities, A is shrouded from B, and B is shrouded from A. It is not wholly true that two contemporaries A and B enjoy a common past. In the first place, even if the occasions in the past of A be identical with the occasions in the past of B, yet A and B by reason of their difference of status, enjoy that past under a difference of perspective elimination. Thus the objective immortality of the past in A differs from the objective immortality of that same past in B. Thus two contemporary occasions, greatly remote from each other, are in effect derived from different pasts.

Again, according to the notions of time recently developed in modern physics, if A and B are contemporaries and P is contemporary with A, then it is not necessarily true that P is contemporary with B. It is possible that P may be earlier than B, or that it may be later than B. Thus even the occasions in the past of A are not wholly identical with those in the past of B. When A and B are neighbouring, then this distinction between their pasts may be negligible. But when they are remote from each other, the distinction may be of major importance.

It follows from this discussion that in so far as the relevant environment is dominated by any uniform type of coördination, any occasion will experience its past as 'anticipating' the prolongation of that type of order into the future beyond that past. But this future includes the occasion in question and its contemporary environment. In this way there is an indirect immanence of its contemporary world in that occasion; not in respect to its particular individual occasions, but as the general substratum for that relation of order. This type of order will both relate the various parts of the contemporary world among themselves, and will also relate these parts to the occasion in

question. But the parts of the contemporary world will only belong to the experience of the occasion in their function of relata for this type of order. This is the general explanation why the contemporary world should be perceived as the field of the uniform spatial relations. It gives no reason why any special system of relationships should dominate this epoch. But the explanation does give a reason why some system of uniform relations should dominate our perceptions of the contemporary world. Also the intrinsic activity has been lost. The contemporary world enters into experience as the passive subject of relations and qualities.

SECTION V. The actualities of the Universe are processes of experience, each process an individual fact. The whole Universe is the advancing assemblage of these processes. The Aristotelian doctrine, that all agency is confined to actuality, is accepted. So also is the Platonic dictum that the very meaning of existence is 'to be a factor in agency,' or in other words 'to make a difference.' Thus, 'to be something' is to be discoverable as a factor in the analysis of some actuality. It follows that in one sense everything is 'real,' according to its own category of being. In this sense the word 'real' can only mean that some sound or mark is a word with a denotation. But the term 'realization' refers to the actual entities which include the entity in question as a positive factor in their constitutions. Thus though everything is real, it is not necessarily realized in some particular set of actual occasions. But it is necessary that it be discoverable somewhere, realized in some actual entity. There is not anything which has failed in some sense to be realized, physically or conceptually. The term 'real' can also mark the differences arising in the contrast between physical and conceptual realization.

SECTION VI. Any set of actual occasions is united by the mutual immanence of occasions, each in the other. To the extent that they are united they mutually constrain each other. Evidently this mutual immanence and constraint of a pair of occasions is not in general a symmetric relation. For, apart from contemporaries, one occasion will be in the future of the other. Thus the earlier will be immanent in the later according to the mode of efficient causality, and the later in the earlier according to the mode of anticipation, as explained above. Any set of occasions, conceived as thus combined into a unity, will be termed a nexus. The unity of such a nexus may be of a trivial description, if the various occasions are dispersed through

the Universe, each with a widely different status from the other. When the unity of the nexūs is of dominating importance, nexūs of different types emerge, which may be respectively termed Regions, Societies, Persons, Enduring Objects, Corporal Substances, Living Organisms, Events, with other analogous terms for the various shades of complexity of which Nature is capable. It will be sufficient in the next chapter to indicate a few of these special types of nexūs.

Section VII. We think of Constraint and Freedom in terms of the values realized in connection with them, and also in terms of the antithesis between them. But there is another way of considering them. We can ask what there is in the physical nature of things constituting the physical realization either of freedom, or of constraint, or of a compatible association of both in a suitable pattern.

In fact we do habitually interpret human history in terms of freedom and constraint. Apart from the realization of this antithesis in physical occurrences, the history of civilized humanity is a meaningless succession of events, involving a play of emotions concerned with concepts entirely irrelevant to the physical facts.

The causal independence of contemporary occasions is the ground for the freedom within the Universe. The novelties which face the contemporary world are solved in isolation by the contemporary occasions. There is complete contemporary freedom. It is not true that whatever happens is immediately a condition laid upon everything else. Such a conception of complete mutual determination is an exaggeration of the community of the Universe. The notions of 'sporadic occurrences' and of 'mutual irrelevance' have a real application to the nature of things. Again the perspective imposed by incompatibilities of subjective form in another way provides for freedom. The antecedent environment is not wholly efficacious in determining the initial phase of the occasion which springs from it. There are factors in the environment which are eliminated from any function as explicit facts in the new creation. The running stream purifies itself, or perhaps loses some virtue which in happier circumstances might have been retained. The initial phase of each fresh occasion represents the issue of a struggle within the past for objective existence beyond itself. The determinant of the struggle is the supreme Eros incarnating itself as the first phase of the individual subjective aim in the new process of actuality. Thus in any two occasions of the Universe there are elements in either one which are irrelevant to the

constitution of the other. The forgetfulness of this doctrine leads to an over-moralization in the view of the nature of things. Fortunately there are a great many things which do not much matter, and we can have them how we will. The opposite point of view has been the nursery of fanaticism, and has tinged history with ferocity.

SECTION VIII. The understanding of the Universe, in terms of the type of metaphysic here put forward, requires that the various rôles of efficient causation, of teleological self-creation, of perspective elimination, of contemporary independence, of the laws of order dominating vast epochs, and of the minor endurances within each epoch, be conceived in their various relations to each other. Another summary expression of this type of understanding is contained in the phrases, Constraint and Freedom, Survival and Destruction, Depth of Feeling and Triviality of Feeling, Conceptual realization and physical realization, Appearance and Reality. Any account of the Adventure of Ideas is concerned with Ideas threading their way among the alternatives presented by these various phrases.

When we examine the structure of the epoch of the Universe in which we find ourselves, this structure exhibits successive layers of types of order, each layer introducing some additional type of order within some limited region which shares in the more general type of order of some larger environment. Also this larger environment in its turn is a specialized region within the general epoch of creation as we know it. Each one of these regions, with its dominant set of ordering relations, can either be considered from the point of view of the mutual relations of its parts to each other, or it can be considered from the point of view of its impact, as a unity, upon the experience of an external percipient. There is yet a third mode of consideration which combines the other two. The percipient may be an occasion within the region, and may yet grasp the region as one, including the percipient itself as a member of it.

A region, analysed in the first way, is thereby conceived as subject to certain Laws of Nature, which laws are its dominant set of ordering relations. In the second mode of consideration, synthesis replaces analysis. The region in question assumes the guise of an enduring unity, of which the essence is a certain complex internal character. This essential character, as it appears in the second approach, is nothing other than the set of Laws of Nature reigning within the region, as they appear in the first approach. Either mode of approach

simply lays stress upon the dominant identity of character pervading the concrete connexity of the many occasions constituting the region. The unity of the region is two-fold:—first, by reason of the sheer connexity arising from the mutual immanence of the various occasions included in it, and secondly, by reason of a pervasive identity of character whereby the various parts play an analogous rôle in any external occasion. Thus the region with its Laws of Nature is a synonym for the enduring substance with its Essential Character.

CHAPTER XIII *THE GROUPING OF OCCASIONS*

SECTION I. The Grouping of Occasions is the outcome of some common function performed by those occasions in the percipient experience. The grouped occasions then acquire a unity; they become, for the experience of the percipient, one thing which is complex by reason of its divisibility into many occasions, or into many subordinate groups of occasions. The subordinate groups are then complex unities, each belonging to the same metaphysical category of existence as the total group. This characteristic, namely divisibility into groups of analogous type of being, is the general notion of extensiveness. The peculiar relationships (if any) diffused systematically between the extensive groups of an epoch constitute the system of geometry prevalent in that epoch.

The general common function exhibited by any group of actual occasions is that of mutual immanence. In Platonic language, this is the function of belonging to a common Receptacle. If the group be considered merely in respect to this basic property of mutual immanence, however otherwise lacking in common relevance, then—conceived as exemplifying this general connectedness—the group is termed a Nexus.

Thus the term Nexus does not presuppose any special type of order, nor does it presuppose any order at all pervading its members other than the general metaphysical obligation of mutual immanence. But in fact the teleology of the Universe, with its aim at intensity and variety, produces epochs with various types of order dominating subordinate nexūs interwoven with each other. A nexus can spread itself

both spatially and temporally. In other words, it can include sets of occasions which are contemporary with each other, and it can include sets which are relatively past and future. If the nexus be purely spatial, then it will include no pair of occasions such that one of the pair is antecedent to the other. The mutual immanence between the occasions of the nexus will then be of the indirect type proper to contemporary occasions. It is for this reason that the notion of externality dominates our intuition of space. If the nexus be purely temporal, then it will include no pair of contemporary occasions. It is to be a mere thread of temporal transition from occasion to occasion. The idea of temporal transition can never be wholly disengaged from that of 'causation.' This latter notion is merely a special way of considering direct immanence of the past in its future.

SECTION II. The notion of the contiguity of occasions is important. Two occasions, which are not contemporary, are contiguous in time when there is no occasion which is antecedent to one of them and subsequent to the other. A purely temporal nexus of occasions is continuous when, with the exception of the earliest and the latest occasions, each occasion is contiguous with an earlier occasion and a later occasion. The nexus will then form an unbroken thread in temporal or serial order. The first and the last occasions of the thread will, of course, only enjoy a one-sided contiguity with the thread.

Spatial contiguity is more difficult to define. It requires a reference to the temporal dimension. It can be defined by the aid of the doctrine that no two contemporary occasions are derived from a past wholly in common. Thus if A and B be two contemporary occasions, the past of A includes some occasions not belonging to the past of B, and that of B includes occasions not belonging to the past of A. Then A and B are contiguous when there is no occasion (i) contemporary with both A and B, and (ii) such that its past includes all occasions, each belonging both to the past of A and the past of B. The particular form of this definition is of no great importance. But the principle that the inter-relations of the present are derived from a reference to the past is fundamental. It gives the reason why the contemporary world is experienced as a display of lifeless substances passively illustrating imposed characters.

Anyhow contiguity, temporal and spatial, is definable in terms of the doctrine of immanence. By the aid of the notion of contiguity, the notion of a region can be defined as denoting a nexus in which

certain conditions of contiguity are preserved. The logical details of such a definition are irrelevant to this discussion.

So far we have been considering various species of nexus, whose sole principle of unity is derived from the bare fact of mutual immanence. We will term this genus of nexus, the genus whose species are discriminated by differences of bare extensive pattern. More briefly, it will be termed the *Genus of Patterned Nexūs*. Every nexus belongs to some species of this genus, if we abstract from the qualitative factors which are interwoven in its patterns.

Section III. We now pass on to the general notion of a *Society*. This notion introduces the general consideration of types of order, and the genetic propagation of order. The definition depends upon taking into account factors which are omitted in the analysis of the Genus of Patterned Nexūs.

A Society is a nexus which 'illustrates' or 'shares in,' some type of 'Social Order.' 'Social Order' can be defined * as follows:—'A nexus enjoys "social order" when (i) there is a common element of form illustrated in the definiteness of each of its included actual entities, and (ii) this common element of form arises in each member of the nexus by reason of the conditions imposed upon it by its prehensions of some other members of the nexus, and (iii) these prehensions impose that condition of reproduction by reason of their inclusion of positive feelings involving † that common form. Such a nexus is called a "society," and the common form is the "defining characteristic" of that society.'

Another rendering †† of the same definition is as follows:—'The point of a "society" as the term is here used, is that it is self-sustaining; in other words, that it is its own reason. Thus a society is more than a set of [actual] entities to which the same class-name applies: that is to say, it involves more than a merely mathematical conception of "order." To constitute a society, the class-name has got to apply to each member, by reason of genetic derivation from other members of that same society. The members of the society are alike because, by reason of their common character, they impose on other members of the society the conditions which lead to that likeness.'

* Cf. *Process and Reality*, Part I, Ch. III, Sec. II.
† In the original, *Process and Reality*, 'of' in place of 'involving'.
†† Cf. *Process and Reality*, Part II, Ch. III, Sec. II

It is evident from this description of the notion of a 'Society,' as here employed, that a set of mutually contemporary occasions cannot form a complete society. For the genetic condition cannot be satisfied by such a set of contemporaries. Of course a set of contemporaries may belong to a society. But the society, as such, must involve antecedents and subsequents. In other words, a society must exhibit the peculiar quality of endurance. The real actual things that endure are all societies. They are not actual occasions. It is the mistake that has thwarted European metaphysics from the time of the Greeks, namely, to confuse societies with the completely real things which are the actual occasions. A society has an essential character, whereby it is the society that it is, and it has also accidental qualities which vary as circumstances alter. Thus a society, as a complete existence and as retaining the same metaphysical status, enjoys a history expressing its changing reactions to changing circumstances.* But an actual occasion has no such history. It never changes. It only becomes and perishes. Its perishing is its assumption of a new metaphysical function in the creative advance of the universe.

The self-identity of a society is founded upon the self-identity of its defining characteristic, and upon the mutual immanence of its occasions. But there is no definite nexus which is the nexus underlying that society, except when the society belongs wholly to the past. For the realized nexus which underlies the society is always adding to itself, with the creative advance into the future. For example, the man adds another day to his life, and the earth adds another millennium to the period of its existence. But until the death of the man and the destruction of the earth, there is no determinate nexus which in an unqualified sense is either the man or the earth.

Section IV. Though there is no one nexus which can claim to be the society, so long as that society is in existence, there is a succession of nexūs each of which is the whole realized society up to that stage of its existence. The extensive patterns of various members of such a succession for a given society may be different. In such a case the extensive patterns, so far as they differ, cannot be any element in the defining characteristic of the society. But the extensive patterns of the various nexūs of the succession may be identical, or

* This notion of 'society' has analogies to Descartes' notion of 'substance', cf. Descartes' *Principles of Philosophy*, Part I, Principles LI-LVII.

at least they may have in common some feature of their pattern. In this case the common pattern, or the common feature, can be one element in the defining characteristic of the society in question.

The simplest example of a society in which the successive nexūs of its progressive realization have a common extensive pattern is when each such nexus is purely temporal and continuous. The society, in each stage of realization, then consists of a set of contiguous occasions in serial order. A man, defined as an enduring percipient, is such a society. This definition of a man is exactly what Descartes means by a thinking substance. It will be remembered that in his *Principles of Philosophy* [Part I, Principle XXI; also *Meditation* III] Descartes states that endurance is nothing else than successive recreation by God. Thus the Cartesian conception of the human soul and that here put forward differ only in the function assigned to God. Both conceptions involve a succession of occasions, each with its measure of immediate completeness.

Societies of the general type, that their realized nexūs are purely temporal and continuous, will be termed 'personal.' Any society of this type may be termed a 'person.' Thus, as defined above, a man is a person.

But a man is more than a serial succession of occasions of experience. Such a definition may satisfy philosophers—Descartes, for example. It is not the ordinary meaning of the term 'man.' There are animal bodies as well as animal minds; and in our experience such minds always occur incorporated. Now an animal body is a society involving a vast number of occasions, spatially and temporally coordinated. It follows that a 'man,' in the full sense of ordinary usage, is not a 'person' as here defined. He has the unity of a wider society, in which the social coördination is a dominant factor in the behaviours of the various parts.

Also, when we survey the living world, animal and vegetable, there are bodies of all types. Each living body is a society, which is not personal. But most of the animals, including all the vertebrates, seem to have their social system dominated by a subordinate society which is 'personal.' This subordinate society is of the same type as 'man,' according to the personal definition given above, though of course the mental poles in the occasions of the dominant personal society do not rise to the height of human mentality. Thus in one sense a dog is a 'person,' and in another sense he is a non-personal

society. But the lower forms of animal life, and all vegetation, seem to lack the dominance of any included personal society. A tree is a democracy. Thus living bodies are not to be identified with living bodies under personal dominance. There is no necessary connection between 'life' and 'personality.' A 'personal' society need not be 'living,' in the general sense of the term; and a 'living' society need not be 'personal.'

SECTION V. The Universe achieves its values by reason of its coördination into societies of societies, and into societies of societies of societies. Thus an army is a society of regiments, and regiments are societies of men, and men are societies of cells, and of blood, and of bones, together with the dominant society of personal human experience, and cells are societies of smaller physical entities such as protons, and so on, and so on. Also all of these societies presuppose the circumambient space of social physical activity.

It is evident that the previous definition of 'society' has been phrased so as to suggest an over-simplified concept of the meaning. For the notion of a defining characteristic must be construed to include the notion of the coördination of societies. Thus there are societies at different levels. For instance, the army is a society at a level different from that of a regiment, and similarly for a regiment and a man. Nature is a complex of enduring objects, functioning as subordinate elements in a larger spatial-physical society. This larger society is for us the natural universe. There is however no reason to identify it with the boundless totality of actual things.

Also each of these enduring objects, such as tables, animal bodies, and stars, is itself a subordinate universe including subordinate enduring objects. The only strictly personal society of which we have direct discriminative intuition is the society of our own personal experiences. We also have a direct, though vaguer, intuition of our derivation of experience from the antecedent functioning of our bodies, and a still vaguer intuition of our bodily derivation from external nature.

Nature suggests for our observation gaps, and then as it were withdraws them upon challenge. For example, ordinary physical bodies suggest solidity. But solids turn to liquids, and liquids to gases. And from the gas the solid can again be recovered. Also the most solid of solids is for certain purposes a viscous fluid. Again impenetrability is a difficult notion. Salt dissolves in water, and can be re-

covered from it. Gases interfuse in liquids. Molecules arise from a patterned interfusion of atoms. Food interfuses with the body, and produces an immediate sense of diffused bodily vigour. This is especially the case with liquid stimulants. Thus the direct immediate experience of impenetrability loses upon challenge its sharp-cut status.

SECTION VI. Another gap is that between lifeless bodies and living bodies. Yet the living bodies can be pursued down to the edge of lifelessness. Also the functionings of inorganic matter remain intact amid the functionings of living matter. It seems that, in bodies that are obviously living, a coördination has been achieved that raises into prominence some functionings inherent in the ultimate occasions. For lifeless matter these functionings thwart each other, and average out so as to produce a negligible total effect. In the case of living bodies the coördination intervenes, and the average effect of these intimate functionings has to be taken into account.

Those activities in the self-formation of actual occasions which, if coördinated, yield living societies are the intermediate mental functionings transforming the initial phase of reception into the final phase of anticipation. In so far as the mental spontaneities of occasions do not thwart each other, but are directed to a common objective amid varying circumstances, there is life. The essence of life is the teleological introduction of novelty, with some conformation of objectives. Thus novelty of circumstance is met with novelty of functioning adapted to steadiness of purpose.

Life may characterize a set of occasions diffused throughout a society, though not necessarily including all, or even a majority of, the occasions of that society. The common element of purpose which characterizes these various occasions must be reckoned as one element of the determining characteristic of the society. It is evident that according to this definition no single occasion can be called living. Life is the coördination of the mental spontaneities throughout the occasions of a society.

But apart from life a high grade of mentality in individual occasions seems to be impossible. A personal society, itself living and dominantly influencing a living society wider than itself, is the only type of organization which provides occasions of high-grade mentality. Thus in a man, the living body is permeated by living societies of low-grade occasions so far as mentality is concerned. But the whole is coördinated so as to support a personal living society of high-

grade occasions. This personal society is the man defined as a person. It is the soul of which Plato spoke.

How far this soul finds a support for its existence beyond the body is: another question. The everlasting nature of God, which in a sense is non-temporal and in another sense is temporal, may establish with the soul a peculiarly intense relationship of mutual immanence. Thus in some important sense the existence of the soul may be freed from its complete dependence upon the bodily organization.

But it is to be noticed that the personality of an animal organism may be more or less. It is not a mere question of having a soul or of not having a soul. The question is, How much, if any? Any tendency to a high-grade multiple personality would be self-destructive by the antagonism of divergent aims. In other words, such multiple personality is destructive of the very essence of life, which is conformation of purpose.

CHAPTER XIV *APPEARANCE AND REALITY*

SECTION I. The objective content of an occasion of experience sorts itself out under two contrasted characters—Appearance and Reality. It is to be noticed that this is not the only dichotomy exhibited in experience. There are the physical and the mental poles, and there are the objects prehended and the subjective forms of the prehensions. In fact this final pair of opposites, Appearance and Reality, is not quite so fundamental metaphysically as the other two pairs.

In the first place the division between appearance and reality does not cover the whole of experience. It only concerns the objective content, and omits the subjective form of the immediate occasion in question. In the second place, its importance is negligible except in the functionings of the higher phases of experience, when the mental functionings have achieved a peculiar complexity of synthesis with the physical functionings. But in these higher phases, the contrast Appearance and Reality dominates those factors of experience which are discriminated in consciousness with peculiar distinctness. Thus the foundation of metaphysics should be sought in the understand-

ing of the subject-object structure of experience, and in the respective rôles of the physical and mental functionings.

Unfortunately the superior dominance in consciousness of the contrast 'Appearance and Reality' has led metaphysicians from the Greeks onwards to make their start from the more superficial characteristic. This error has warped modern philosophy to a greater extent than ancient or mediaeval philosophy. The warping has taken the form of a consistent reliance upon sensationalist perception as the basis of all experiential activity. It has had the effect of decisively separating 'mind' from 'nature,' a modern separation which found its first exemplification in Cartesian dualism. But it must be remembered that this modern development was only the consistent carrying out of principles already present in the older European philosophy. It required two thousand years for the full implication of those principles to dawn upon men's minds in the seventeenth and the eighteenth centuries after Christ.

Section II. The distinction between 'appearance and reality' is grounded upon the process of self-formation of each actual occasion. The objective content of the initial phase of reception is the real antecedent world, as given for that occasion. This is the 'reality' from which that creative advance starts. It is the basic fact of the new occasion, with its concordances and discordances awaiting coördination in the new creature. There is nothing there apart from the real agency of the actual past, exercising its function of objective immortality. This is reality, at that moment, for that occasion. Here the term 'reality' is used in the sense of the opposite to 'appearance.'

The intermediate phase of self-formation is a ferment of qualitative valuation. These qualitative feelings are either derived directly from qualities illustrated in the primary phase, or are indirectly derived by their relevance to them. These conceptual feelings pass into novel relations to each other, felt with a novel emphasis of subjective form. The ferment of valuation is integrated with the physical prehensions of the physical pole. Thus the initial objective content is still there. But it is overlaid by, and intermixed with, the novel hybrid prehensions derived from integration with the conceptual ferment. In the higher types of actual occasions, propositional feelings are now dominant. This enlarged objective content obtains a coördination adapting it to the enjoyments and purposes fulfilling the subjective aim of the new occasion.

The mental pole has derived its objective content alike by abstraction from the physical pole and by the immanence of the basic Eros which endows with agency all ideal possibilities. The content of the objective universe has passed from the function of a basis for a new individuality to that of an instrument for purposes. The individual process is now feeling its own completion:—Cogito, ergo sum. And in Descartes' phraseology, 'cogitatio' is more than mere intellectual understanding.

This difference between the objective content of the initial phase of the physical pole and the objective content of the final phase, after the integration of physical and mental poles, constitutes 'appearance' for that occasion. In other words, 'appearance' is the effect of the activity of the mental pole, whereby the qualities and coördinations of the given physical world undergo transformation. It results from the fusion of the ideal with the actual:—The light that never was, on sea or land.

SECTION III. There can be no general metaphysical principles which determine how in any occasion appearance differs from the reality out of which it originates. The divergencies between reality and appearance depend on the type of social order dominating the environment of the occasion in question. All our information on this topic, direct and inferential, concerns this general epoch of the Universe and, more particularly, animal life on the surface of the Earth.

In respect to the occasions which compose the societies of inorganic bodies or of the so-called empty spaces, there is no reason to believe that in any important way the mental activities depart from functionings which are strictly conformal to those inherent in the objective datum of the first phase. Thus no novelty is introduced. The perspective elimination is effected according to the 'laws of nature' inherent in the epoch. This composition of activities constitutes the laws of physics. There is no effective 'appearance.'

But the case is very different for the high-grade occasions which are components in the animal life on the Earth's surface. Each animal body is an organ of sensation. It is a living society which may include in itself a dominant 'personal' society of occasions. This 'personal' society is composed of occasions enjoying the individual experiences of the animals. It is the soul of man. The whole body is organized, so that a general coördination of mentality is finally poured into the successive occasions of this personal society. Thus in the

constitutions of these occasions, appearance is sufficiently coördinated to be effective. Also consciousness arises in the subjective forms in these experiences of the higher animals. It arises peculiarly in connection with the mental functions, and has to do primarily with their product. Now appearance is one product of mentality. Thus in our conscious perceptions appearance is dominant. It possesses a clear distinctness, which is absent from our vague massive feeling of derivation from our actual world. Appearance has shed the note of derivation. It lives in our consciousness as the world presented to us for our enjoyment and our purposes. It is the world in the guise of a subject-matter for an imposed activity. The occasion has gathered the creativity of the Universe into its own completeness, abstracted from the real objective content which is the source of its own derivation.

This status of 'appearance' in the constitution of experience is the reason for the disastrous metaphysical doctrine of physical matter passively illustrating qualities, and devoid of self-enjoyment. As soon as clarity and distinctness are made the test of metaphysical importance, an entire misapprehension of the metaphysical status of appearance is involved.

Section IV. When the higher functionings of mentality are socially stabilized in an organism, appearance merges into reality. To take the most conspicuous example, consider the personal succession of experiences in the life of a human being. The present occasion in this personal life inherits with peculiar dominance the antecedent experiences in this succession. But these antecedent experiences include the 'appearances' as in those occasions. These antecedent appearances are part of the real functioning of the real actual world as it stands in the primary phase of the immediately present occasion. It is a real fact of nature that the world has appeared thus from the standpoint of these antecedent occasions of the personal life. And more generally, dropping the special case of personality, the objective reality of the past, as it now functions in the present, in its day was appearance. It may be strengthened in emphasis, embroidered upon, and otherwise modified by the novel appearances of the new occasion. In this way, there is an intimate, inextricable fusion of appearance with reality, and of accomplished fact with anticipation. In truth, we have been describing the exact situation which human experience presents for philosophic analysis.

We are apt to think of this fusion from the point of view of the higher grades of human beings. But it is a fusion proceeding throughout nature. It is the essential mode in which novelty enters into the functionings of the world.

SECTION V. It is a mistake to suppose that, at the level of human intellect, the rôle of mental functionings is to add subtlety to the content of experience. The exact opposite is the case. Mentality is an agent of simplification; and for this reason appearance is an incredibly simplified edition of reality. There should be no paradox in this statement. A moment's introspection assures one of the feebleness of human intellectual operations, and of the dim massive complexity of our feelings of derivation. The point for discussion is how in animal experience this simplification is effected.

The best example of this process of simplification is afforded by the perception of a social nexus as a unity, characterized by qualities derived from its individual members and their interconnections. With some elimination, the defining characteristic of the nexus is directly perceived to be qualifying that nexus as a unity. It often happens that in this perception of the nexus as thus qualified there is a wavering between the ascription of the quality to the group as one, and to its individual components as many. Thus, the orchestra is loud as one entity, and also in virtue of the perceived loudness of the individual members with their musical instruments. The transference of the characteristic from the individuals to the group as one can be explained by the mental operations. There is the conceptual entertainment of the qualities illustrated by the individual actualities. The qualities shared by many individuals are fused into one dominating impression. This dominating prehension is integrated with the nexus, or with some portion of it, perceived as a unity illustrating that quality. The association of a nexus as one with a quality will, for the experient subject, be in general a mode of exemplification which differs from the mode in which the respective individuals illustrate it. The discipline of a regiment inheres in the regiment in a different mode from its inherence in the individual soldiers. This difference of mode of illustration may be more or less evident. But it is there. It gives another reason for the aspect of the passive inherence of quality in substance. The composite group illustrates its qualities passively. The activity belongs to the individual actualities. This whole question of the transference of quality from the many indi-

viduals to the nexus as one is discussed at length in *Process and Reality,* Part III, Chapter III, Section IV, where it is termed 'Transmutation.' Obviously the transmuted percept belongs to Appearance. But as it occurs in animal experience, it belongs to appearance merged with reality. For it is inherited from the past. It is thus a fact of nature that the world so appears. It is a structural relationship of animate nature on the Earth's surface. In all Appearance there is an element of Transmutation.

SECTION VI. For animal life on Earth by far the most important example of Transmutation is afforded by Sense-Perception. No doctrine of sense-perception can neglect the teaching of physiology. The decisive factor in sense-perception is the functioning of the brain, and the functioning of the brain is conditioned by the antecedent functionings of the other parts of the animal body. Given requisite bodily functionings, the sense-perception results. The activities of nature external to the animal body are irrelevant as to their details, so long as they have the general character of supporting the existence of the total animal organism. The human body is the self-sufficient organ of human sense-perception.

There are external events, such as the transmission of light or the movements of material bodies which respectively are the normal modes of exciting sense-percepts of particular types. But in the first place these external events are only the normal modes. A diet of drugs will do equally well, though its issue in perception is not so definitely to be predicted. Thus no one type of external event is necessarily associated with one type of sense-percept. Hardly any percept is strictly normal. Gross illusions are plentiful, and some element of illusion almost universal. An ordinary looking-glass produces illusive percepts in almost every room.

Secondly, confining ourselves to the normal modes of excitation, the only important factor in the external event is how it affects the functionings of the surface of the body. How the light enters the eye, and a normal healthy state of the body, are the only important factors in normal visual sensation. The light may have come from a nebula distant by a thousand light-years, or it may have its origin in an electric lamp two feet off and have suffered a complex arrangement of reflections and refractions. Nothing matters except how it enters the eye, as to its composition, its intensity, and its geometric ordering. The body is supremely indifferent as to the past history of its

exciting agents, and requires no certificate of character. The peculiar bodily excitement is all that matters.

The conclusion is that the direct information to be derived from sense-perception wholly concerns the functionings of the animal body. The sense of unity with the body does in fact dominate our sense-experiences. But the bodily organization is such as finally to promote a wholesale transmutation of sensa, inherited from antecedent bodily functionings, into characteristics of regions with well-marked geometrical relations to the geometrical structures of these functionings. In this transmutation the experient occasion in question belongs to the personal succession of occasions which is the soul of the animal. The bodily functionings and the nexūs relevant to them by geometrical relationship are immanent in the experient occasion. The qualitative inheritance from the individual occasion implicated in these functionings is transmuted into the characteristics of regions conspicuously indicated by their geometrical connections. This doctrine is plainly indicated in the analysis of optical vision, where the image occupies the region indicated by geometrical relations within the eyes. It is more obscurely evident in the case of other species of sensa.

It is to be remembered also that along the personal succession of the soul's experiences, there is an inheritance of sense-perception from the antecedent members of the personal succession. Also incipient sense-percepta may be forming themselves in the nerve-routes, or in the neighbouring regions of the brain. But the final synthesis, with its production of appearance, is reserved for the occasions belonging to the personal soul.

Section VII. The question of the proper description of the species of qualities termed 'sensa' is important. Unfortunately the learned tradition of philosophy has missed their main characteristic, which is their enormous emotional significance. The vicious notion has been introduced of mere receptive entertainment, which for no obvious reason by reflection acquires an affective tone. The very opposite is the true explanation. The true doctrine of sense-perception is that the qualitative characters of affective tones inherent in the bodily functionings are transmuted into the characters of regions. These regions are then perceived as associated with those character-qualities, but also these same qualities are shared by the subjective forms of the prehensions. This is the reason of the definite æsthetic attitude

imposed by sense-perception. The pattern of sensa characterizing the object—that is, those sensa in that pattern of contrast—enters also into the subjective form of the prehension. Thus art is possible. For not only can the objects be prescribed, but also the corresponding affective tones of their prehensions. This is the æsthetic experience so far as it is based upon sense-perception.

Section VIII. Another point to be noticed is that in sense-perception a region in the contemporary world is the substratum supporting the sensa. It is the region straight-away in such-and-such a direction. But this geometrical relation of being 'straight-away in such-and-such a direction' is defined by the operations of the brain. It has nothing to do with any physical transmission from the substrate region to the brain. To judge from some descriptions of perception in terms of modern scientific theories, it might be concluded that we perceive along the track of a ray of light. There is not the slightest warrant for such a notion. The track of light in the world external to the animal body is irrelevant. The coloured region is perceived straight-away in such-and-such a direction. This is the fundamental notion of 'straightness.'

It therefore becomes necessary for the self-consistency of this doctrine to enquire whether the dominant structure of geometrical relations includes a determination of straightness. The theory requires that a prehension of a nexus within the brain as exhibiting straightness in the mutual relations of its parts should thereby determine the prolongation of those relations into regions beyond the brain. In simpler language, a segment of a straight line as prehended within the brain should necessarily determine its prolongation externally to the body, irrespective of the particular characters of the external events. The possibility of 'Transmutation' involving the 'Projection' of sensa is then secured.

I have discussed this question elsewhere,* and have given a definition of straight lines—and, more generally, of flatness—which satisfies the requirements. The necessity of basing straightness upon measurement, and measurement upon particular happenings is thereby avoided. The notions of straightness and of congruence, and thence

* Cf. *Process and Reality*, Part IV, Chapters III, IV, and V. The required definition is given in Chapter III, and the theory of the projection of sensa is discussed in Chapters IV and V.

of distance, can be derived from those underlying a uniform systematic non-metrical geometry.

It may be noticed in passing that, if straightness depends upon measurement, there can be no perception of straightness in the unmeasured. The notion of 'straight in front' must then be meaningless.

SECTION IX. In this way, the inheritance from the past is precipitated upon the present. It becomes sense-perception, which is the 'appearance' of the present.

The 'mutual immanence' of contemporary occasions to each other is allied to the immanence of the future in the present, though it presents some features of its own. This immanence exhibits a symmetrical relation of causal independence. In human experience, the prehensions of the contemporary world exhibit themselves as sense-perceptions, effected by means of the bodily organs of sensation. The subjective forms of these sense-perceptions involve conscious discrimination, with varying degrees of clarity and distinctness. Indeed sense-perceptions can exhibit themselves as clear and distinct in consciousness to a degree unrivalled by any other type of prehension. The result is that all attempts at an exact systematic doctrine of the nature of things seeks its most obvious verification in the conformity of its theory with sense-perception. The unfortunate effect has been, that all direct observation has been identified with sense-perception. This assumption has been criticized in Chapter XI.

But sense-perception, as conceived in the isolation of its ideal purity, never enters into human experience. It is always accompanied by so-called 'interpretation.' This 'interpretation' does not seem to be necessarily the product of any elaborate train of intellectual cogitation. We find ourselves 'accepting' * a world of substantial objects, directly presented for our experience. Our habits, our states of mind, our modes of behaviour, all presuppose this 'interpretation'. In fact the concept of mere sensa is the product of high-grade thinking. It required Plato to frame the myth of the Shadows in the Cave, and it required Hume to construct the doctrine of pure sensationalist perception. Yet even animals share in some 'interpretation'. There is

* Cf. *'Perception'*, by H. H. Price, especially Chapter VI, *'Perceptual Assurance, Perceptual Acceptance'* (Methuen, London, 1932). Price in his valuable work gives to sense-perception a more fundamental rôle in experience than my doctrine allows to it. Cf. also Santayana's doctrine of 'Animal Faith'.

every evidence that animals enjoy a sensationalist experience. Dogs smell, eagles see, and noises attract the attention of most of the higher animals. Also their consequent modes of behaviour suggest their immediate assumption of a substantial world around them. In fact the hypothesis of a mere sensationalist perception does not account for our direct observation of the contemporary world. There is some other factor present, which is equally primitive with our perception of sensa. This factor is provided by the immanence of the past in the immediate occasion whose percipience is under discussion. The immanence of the past in this percipient occasion cannot be fully understood apart from due attention to the doctrine of the immanence of the future in the past. Thus the past as an objective constituent in the experience of the percipient occasion carries its own prehension of the future beyond itself. This prehension survives objectively in the primary phase of the percipient. Accordingly there is an indirect prehension of contemporary occasions, *via* the efficient causation from which they arise. For the immediate future of the immediate past constitutes the set of contemporary occasions for the percipient. Also these prehensions of immediate past and of immediate future operate dominantly in their experience of their respective subjects. Thus the prehension of contemporary occasions is the prehension of those occasions in so far as they are conditioned by the occasions in the immediate past of the prehending subject. Thus the present is perceivable in so far as it is conditioned by the efficient causation from the past of the perceiver. The great dominant relationships, fundamental for the epochal order of nature, thereby stand out with overwhelming distinctness. These are the general, all-pervasive, obligations of perspective. Such relationships are what we term the spatial relationships as perceivable from the standpoint of the observer.

But the particular occasions of the contemporary world, each with its own individual spontaneity, are veiled from the observer. In this respect, the contemporary world in the experience of the percipient shares the characteristics of the future. The relevant environment, which is the immediate past of the human body, is peculiarly sensitive to its geometrical experiences and to the synthesis of its qualitative prehensions with these experiences of geometrical relations. In this way, there is a basis in fact for the association of derivates from significant regions in the past with the geometrical representatives

of those regions in the present. [Cf. *Process and Reality,* Part III, Ch. III, Sec. IV, and Part IV, Chs. IV and V].

The conclusion is that the contemporary world is not perceived in virtue of its own proper activity, but in virtue of activities derived from the past, the past which conditions it and which also conditions the contemporary percipient. These activities are primarily in the past of the human body, and more remotely in the past of the environment within which the body is functioning. This environment includes those occasions dominantly conditioning the perceived contemporary regions. This theory of the perception of contemporaries allows for our habitual belief that we perceive the contemporary world with a general qualitative relevance to the essences of the occasions making up its various regions; and also with a bias of qualitative distortion due to the functioning of the animal body of the percipient.

One distortion stands out immediately. Each actual occasion is in truth a process of activity. But the contemporary regions are mainly perceived in terms of their passive perspective relationship to the percipient and to each other. They are thus perceived merely as passive recipients of the qualities with which in sense-perception they are associated. Hence the false notion of a substratum with vacuously inherent qualities. Here the term 'vacuous' means 'devoid of any individual enjoyment arising from the mere fact of realization in that context'. In other words, the substratum with its complex of inherent qualities is wrongly conceived as bare realization, devoid of self-enjoyment, that is to say, devoid of intrinsic worth. In this way, the exclusive reliance on sense-perception promotes a false metaphysics. This error is the result of high-grade intellectuality. The instinctive interpretations which govern human life and animal life presuppose a contemporary world throbbing with energetic values. It requires considerable ability to make the disastrous abstraction of our bare sense-perceptions from the massive insistency of our total experiences. Of course, whatever we can do in the way of abstraction is for some purposes useful—provided that we know what we are about.

CHAPTER XV *PHILOSOPHIC METHOD*

SECTION I. In this final chapter of Part III my aim is a discussion of some methods which can usefully be employed in the pursuit of speculative philosophy. In illustration, and as a subsidiary aim, I shall refer to some doctrines of my own, and to some comments upon them. In this chapter the transient aspect of nature will be mainly emphasized.

So far as concerns methodology, the general issue of the discussion will be that theory dictates method, and that any particular method is only applicable to theories of one correlate species. An analogous conclusion holds for the technical terms. This close relation of theory to method partly arises from the fact that the relevance of evidence depends on the theory which is dominating the discussion. This fact is the reason why dominant theories are also termed 'working hypotheses'.

An example is afforded when we interrogate experience for direct evidence of the interconnectedness of things. If we hold with Hume, that the sole data originating reflective experience are impressions of sensation, and also if we also admit with him the obvious fact that no one such impression by its own individual nature discloses any information as to another such impression, then on that hypothesis the direct evidence for interconnectedness vanishes. Again, if we hold the Cartesian doctrine of substantial souls with many adventures of experience, and of substantial material bodies, then on that hypothesis the relations between two occasions of experience qualifying one soul are no evidence as to the connectedness of two such occasions respectively qualifying two different souls, and are no evidence as to the connectedness of a soul and a material body, and are no evidence as to the connectedness of two occasions of agitation of one material body, or of two such occasions respectively belonging to different material bodies. But if we hold, as for example in *Process and Reality,* that all final individual actualities have the metaphysical character of occasions of experience, then on that hypothesis the direct evidence as to the connectedness of one's immediate present occasion of experience with one's immediately past occasions, can be validly used to suggest categories applying to the connectedness of all occasions in nature. A great deal of confused

philosophical thought has its origin in obliviousness to the fact that the relevance of evidence is dictated by theory. For you cannot prove a theory by evidence which that theory dismisses as irrelevant. This is also the reason that in any science which has failed to produce any theory with a sufficient scope of application, progress is necessarily very slow. It is impossible to know what to look for, and how to connect the sporadic observations. Philosophical discussion in the absence of a theory has no criterion of the validity of evidence. For example, Hume assumes that his doctrine of association holds for all types of impressions of sensation and of ideas of them indiscriminately. This assumption is part of his theory. In divorce from the theory, a separate appeal to experience is required for each type of impression, for example, tastes, sounds, sights, etc., and likewise, not only for the association of tastes *inter se* and of sounds *inter se,* but for the association of tastes with sounds, and so on for every possible type, and for every possible conjunction of types.

To sum up this preface, every method is a happy simplification. But only truths of a congenial type can be investigated by any one method, or stated in the terms dictated by the method. For every simplification is an over-simplification. Thus the criticism of a theory does not start from the question, True or false? It consists in noting its scope of useful application and its failure beyond that scope. It is an unguarded statement of a partial truth. Some of its terms embody a general notion with a mistaken specialization, and others of its terms are too general and require discrimination of their possibilities of specialization.

SECTION II. Philosophy is a difficult subject, from the days of Plato to the present time haunted by subtle perplexities. The existence of such perplexities arising from the common obviousness of speech is the reason why the topic exists. Thus the very purpose of philosophy is to delve below the apparent clarity of common speech. In this connection, it is only necessary to refer to Socrates. Another illustration is to be found in the *Sophist,* where Plato states that 'not-being' is a form of 'being'. This statement is at once an extreme instance of the breakdown of language, and the enunciation of a profound metaphysical truth which lies at the foundation of this discussion.

SECTION III. Speculative Philosophy can be defined * as the endeavour to frame a coherent, logical, necessary system of general

* Cf. *Process and Reality,* Pt. I, Ch. I, Sec. I.

ideas in terms of which every element of our experience can be interpreted. Here 'interpretation' means that each element shall have the character of a particular instance of the general scheme.

Thus speculative philosophy embodies the method of the 'working hypothesis'. The purpose of this working hypothesis for philosophy is to coördinate the current expressions of human experience, in common speech, in social institutions, in actions, in the principles of the various special sciences, elucidating harmony and exposing discrepancies. No systematic thought has made progress apart from some adequately general working hypothesis, adapted to its special topic. Such an hypothesis directs observation, and decides upon the mutual relevance of various types of evidence. In short, it prescribes method. To venture upon productive thought without such an explicit theory is to abandon oneself to the doctrines derived from one's grandfather.

In the preliminary stages of knowledge a haphazard criterion is all that is possible. Progress is then very slow, and most of the effort is wasted. Even an inadequate working hypothesis with some conformation to fact is better than nothing. It coördinates procedure.

The advance of any reasonably developed science is two-fold. There is the advance of detailed knowledge within the method prescribed by the reigning working hypothesis; and there is the rectification of the working hypothesis dictated by the inadequacies of the current orthodoxy.

Sometimes it is necessary for a science to entertain concurrently two—or more—working hypotheses, each with its own success and its own failure. Such hypotheses are contradictory as stated; and science awaits their conciliation by the production of a working hypothesis with a wider sweep. When a new working hypothesis is proposed, it must be criticized from its own point of view. For example, it is futile to object to the Newtonian dynamics that, on the Aristotelian system, the loose things on the earth's surface must be left behind by the earth's motion.

Philosophy has been afflicted by the dogmatic fallacy, which is the belief that the principles of its working hypotheses are clear, obvious, and irreformable. Then, as a reaction from this fallacy, it has swayed to the other extreme which is the fallacy of discarding method. Philosophers boast that they uphold no system. They are then a prey to the delusive clarities of detached expressions which it is the very purpose of their science to surmount. Another type of

reaction is to assume, often tacitly, that if there can be any intellectual analysis it must proceed according to some one discarded dogmatic method, and thence to deduce that intellect is intrinsically tied to erroneous fictions. This type is illustrated by the anti-intellectualism of Nietzsche and Bergson, and tinges American Pragmatism.

SECTION IV. A method is a way of dealing with data, with evidence. What are the evidences to which philosophy appeals?

It is customary to contrast the objective approach of the ancient Greeks with the subjective approach of the moderns, initiated by Descartes, and further emphasized by Locke and Hume.

But, whether we be ancient or modern, we can only deal with things, in some sense, experienced. The Greeks dealt with things that they thought they experienced, and Hume merely asked, What do we experience? This is exactly the question which Plato and Aristotle thought that they were answering.

To speak of anything, is to speak of something which, by reason of that very speech, is in some way a component in that act of experience. In some sense or other, it is thereby known to exist. This is what Plato pointed out when he wrote, Not-being is itself a sort of being.

Speech consists of noises, or visible shapes, which elicit an experience of things other than themselves. In so far as vocables fail to elicit a stable coördination of sound-character, or shape-character, to meaning, those vocables fail to function as speech. And in so far as some meaning is not in some sense directly experienced, there is no meaning conveyed. To point at nothing is not to point.

To speak of the same thing twice is to demonstrate that the being of that thing is independent of either singular act of speech, unless we believe that the two acts presuppose each other or are both presupposed by the thing spoken of. If we cannot speak of the same thing twice, knowledge vanishes taking philosophy with it. Thus, since speech can be repeated, things spoken of have a determined being in abstraction from the occasion of experience which includes that act of speech.

The difference between ancients and moderns is that the ancients asked what have we experienced, and the moderns asked what can we experience. But in both cases, they asked about things transcending the act of experience which is the occasion of asking.

SECTION V. The translation of Hume's question from 'What *do*

we experience' to 'What *can* we experience' makes all the difference, though in his 'Treatise' Hume makes the transition, time and again, without explicit comment. For modern epistemology the latter form of the question—with its substitution of *can* for *do*—is accompanied by the implicit presupposition of a method, namely that of placing ourselves in an introspective attitude of attention so as to determine the *given* components of experience in abstraction from our private way of subjective reaction, by reflexion, conjecture, emotion, and purpose.

In this attitude of strained attention, there can be no doubt as to the answer. The data are the patterns of sensa provided by the sense organs. This is the sensationalist doctrine of Locke and Hume. Later, Kant has interpreted the patterns as forms introduced by the mode of reception provided by the recipient. Here Kant introduces the Leibnizian notion of the self-development of the experiencing subject. Thus for Kant the data are somewhat narrower than for Hume: they are the sensa devoid of their patterns. Hume's general analysis of the consequences of this doctrine stands unshaken. So also does his final reflection, that the philosophic doctrine fails to justify the practice of daily life. The justification of this procedure of modern epistemology is twofold, and both of its branches are based upon mistakes. The mistakes go back to the Greek philosophers. What is modern, is the exclusive reliance upon them.

Section VI. The first error is the assumption of a few definite avenues of communication with the external world, the five sense-organs. This leads to the pre-supposition that the search for the data is to be narrowed to the question, what data are directly provided by the activity of the sense-organs—preferably the eyes. This doctrine of sense-organs has a vague, general truth, very important for practical affairs. In particular all exact scientific observation is derived from such data. The scientific categories of thought are obtained elsewhere.

But the living organ of experience is the living body as a whole. Every instability of any part of it—be it chemical, physical, or molar —imposes an activity of readjustment throughout the whole organism. In the course of such physical activities human experience has its origin. The plausible interpretation of such experience is that it is one of the natural activities involved in the functioning of such a high-grade organism. The actualities of nature must be so interpreted

as to be explanatory of this fact. This is one *desideratum* to be aimed at in a philosophic scheme.

Such experience seems to be more particularly related to the activities of the brain. But how far an exact doctrine can be based upon this presumption lies beyond our powers of observation. We cannot determine with what molecules the brain begins and the rest of the body ends. Further, we cannot tell with what molecules the body ends and the external world begins. The truth is that the brain is continuous with the body, and the body is continuous with the rest of the natural world. Human experience is an act of self-origination including the whole of nature, limited to the perspective of a focal region,* located within the body, but not necessarily persisting in any fixed coördination with a definite part of the brain.

SECTION VII. The second error is the presupposition that the sole way of examining experience is by acts of conscious introspective analysis. Such a doctrine of the exclusive primacy of introspection is already discredited in psychology. Each occasion of experience has its own individual pattern. Each occasion lifts some components into primacy and retreats others into a background enriching the total enjoyment. The attitude of introspection shares this characteristic with all other experiential occasions. It lifts the clear-cut data of sensation into primacy, and cloaks the vague compulsions and derivations which form the main stuff of experience. In particular it rules out that intimate sense of derivation from the body, which is the reason for our instinctive identification of our bodies with ourselves.

In order to discover some of the major categories under which we can classify the infinitely various components of experience, we must appeal to evidence relating to every variety of occasion. Nothing can be omitted, experience drunk and experience sober, experience sleeping and experience waking, experience drowsy and experience wide-awake, experience self-conscious and experience self-forgetful, experience intellectual and experience physical, experience religious and experience sceptical, experience anxious and experience care-free, experience anticipatory and experience retrospective, experience happy and experience grieving, experience dominated by emotion and experience under self-restraint, experience in the light and experience in the dark, experience normal and experience abnormal.

* Cf. *Process and Reality*, Pt. II, Ch. III, especially Secs. IV-XI, and Pt. IV, Chs. IV and V.

SECTION VIII. We have now reached the heart of our topic. What is the store-house of that crude evidence on which philosophy should base its discussion, and in what terms should its discussion be expressed?

The main sources of evidence respecting this width of human experience are language, social institutions, and action, including thereby the fusion of the three which is language interpreting action and social institutions.

Language delivers its evidence in three chapters, one on the meanings of words, another on the meanings enshrined in grammatical forms, and the third on meanings beyond individual words and beyond grammatical forms, meanings miraculously revealed in great literature.

Language is incomplete and fragmentary, and merely registers a stage in the average advance beyond ape-mentality. But all men enjoy flashes of insight beyond meanings already stabilized in etymology and grammar. Hence the rôle of literature, the rôle of the special sciences, and the rôle of philosophy:—in their various ways engaged in finding linguistic expressions for meanings as yet unexpressed.

As a special example, consider the line and a half of poetry in which Euripides * compresses the main philosophical problems which have tortured European thought from his day to the present:—'Zeus, whether thou art Compulsion of Nature or Intelligence of Mankind, to thee I prayed.' Consider the ideas involved, 'Zeus', 'necessity [compulsion] of nature', 'intelligence of mankind', 'prayer'. These lines have survived the ages with a modern appeal vivid as when first they thrilled an Athenian audience. The biographer † of a modern statesman cites them to express the solemnity of the spectacle of life passing into religious emotion.

Yet Hume would be able to find no 'impression of sensation' from which to derive 'Zeus', or 'compulsion', or 'intelligence', or the would-be 'persuasiveness' which we term 'prayer'. John Morley himself selected the quotation in spite of his own positivistic bias which should trivialize these meanings. Also, perhaps even for their original author, the lines represent a triumph of dramatic intuition over temperamental scepticism.

* *Trojan Women*, 886–7.

† Cf. John Morley's *Life of Gladstone*, Ch. X.

The common practice, interpreted by the common language of mankind, tells the same tale. A statesman, or a president of a business corporation, assumes the 'compulsion of recent events' [ἀνάγκη φύσεως] as laying down inexorable conditions for the future. He frames a 'policy' upon this assumption and advises that it be 'acted on', thereby also assuming that the imposed conditions leave room for the effectiveness of 'choice' and 'intelligence' [νοῦς]. He assumes alternatives in contrast to the immediate fact. He conceives an ideal, to be attained or to be missed. He conceives such ideals as effective in proportion as they are entertained. He praises and he blames by reason of this belief.

In the world, there are elements of order and disorder, which thereby presuppose an essential interconnectedness of things. For disorder shares with order the common characteristic that they imply many things interconnected.

Each experient enjoys a perspective apprehension of the world, and equally is an element in the world by reason of this very prehension, which anchors him to a world transcending his own experience. For, it belongs to the nature of this perspective derivation, that the world thus disclosed proclaims its own transcendence of that disclosure. To every shield, there is another side, hidden.

Thus an appeal to literature, to common language, to common practice, at once carries us away from the narrow basis for epistemology provided by the sense-data disclosed in direct introspection. The world within experience is identical with the world beyond experience, the occasion of experience is within the world and the world is within the occasion. The categories have to elucidate this paradox of the connectedness of things:—the many things, the one world without and within.

Section IX. European philosophy is founded upon Plato's dialogues, which in their methods are mainly an endeavour to elicit philosophic categories from a dialectic discussion of the meanings of language taken in combination with shrewd observation of the actions of man and of the forces of nature.

But in one dialogue, the *Sophist,* Plato explicitly considers the methods of philosophy. One of his conclusions is to point out the limitations of common speech. Mere dialectic, uncriticized, is a fallacious instrument, the mark of the *Sophist.* For example, Plato insists that not-being is itself a form of being. Thus in philosophy linguistic

discussion is a tool, but should never be a master. Language is imperfect both in its words and in its forms. Thus we discover two main errors to which philosophic method is liable, one is the uncritical trust in the adequacy of language, and the other is the uncritical trust in the strained attitude of introspection as the basis for epistemology.

But since the life-time of Plato nearly two and a half thousand years have intervened, including the continuous activity of European philosophic thought, pagan, Christian, secular. It is widely held that a stable, well-known philosophic vocabulary has been elaborated, and that in philosophic discussion any straying beyond its limits introduces neologisms, unnecessary and therefore to be regretted.

This alleged fact requires examination. In the first place, if the allegation be true, it is very remarkable. It decisively places philosophy apart from the more special sciences. Modern mathematics, most secure and authoritative of sciences, is largely written in verbal and symbolic phrases which would have been unintelligible eighty years ago. In modern physics the old words, where they are still used, convey different meanings, and the new words are abundant. But it is futile to make a catalogue of the sciences accompanied by this refrain. The conclusion is obvious to the most cursory inspection.

Section X. Undoubtedly, philosophy is dominated by its past literature to a greater extent than any other science. And rightly so. But the claim that it has acquired a set of technical terms sufficient for its purposes, and exhaustive of its meanings, is entirely unfounded. Indeed its literature is so vast, and the variations of its schools of thought so large, that there is abundant evidence of most excusable ignorance respecting verbal usages.

A recent instance illustrates the vagueness of philosophical terminology. Logic is, by far, that branch of philosophy best systematized with the aid of a stable technical language. Consider the terms Judgment and Proposition. I am not writing a preface to Logic, so I will confine myself to the assertion that there is considerable variation in the usages of these terms among logicians.

Also we may well ask whether there are not subtle variations of meaning stretching far beyond the competence of the two-term vocabulary,—Judgment, Proposition. For example, Mr. Joseph * has been examining Mr. W. E. Johnson's use of the term Proposition

* Cf. *Mind*, Vols. 36, 37, New Series.

in his well-known Logical Treatise. Mr. Joseph finds twenty distinct meanings. It is to be remembered that we are here referring to two of the most acute of modern logicians. Whether Mr. Joseph has rightly interpreted Mr. Johnson's phrases is not to the point. If Mr. Joseph has found twenty distinct, though allied, meanings closely connected with the term Proposition, there are twenty such meanings, even though for the moment their divergencies may seem unimportant to Mr. Johnson or to Mr. Joseph. Importance depends on purpose and on point of view. So at any moment twenty new terms may be required by some advance in the subtlety of logical theory. Again, if Mr. Johnson has employed twenty distinct meanings, it is because they were relevant to his argument, even though his argument may require further completion by reason of their unnoted distinction.

It is safe to affirm that this situation can be repeated over every technical term in philosophy.

SECTION XI. Another illustration, in which my use of the words * Prehension, Feeling, Satisfaction, is partly concerned, can be drawn from the terms expressive of the connectedness of things. For this topic, the reigning philosophical term is the word Relation. There are various controversies about relations which need not be explicitly referred to. But there is one discussion which illustrates our immediate topic.

It is generally held that relations are universals, so that A can have the same relation to B as C has to D. For example 'loving', 'believing', 'between', 'greater than', are relations. There can be no objection to this doctrine. For it is a mere definition. Universals which require two or more particulars for their illustration need some term to indicate them, and Relation is the word chosen.

But with this meaning to the term, a relation cannot signify the actual connectedness of the actual individual things which constitute the actual course of history. For example, New York lies between Boston and Philadelphia. But the connectedness of the three towns is a real particular fact on the earth's surface involving a particular part of the eastern seaboard of the United States. It is not the universal 'between'. It is a complex actual fact which, among other things, exemplifies the abstract universal 'betweenness'.

This consideration is the basis of Bradley's objection that relations

* Cf. *Science and the Modern World,* Ch. IV and *passim* and *Process and Reality,* Part I, Ch. II and *passim.*

do not relate. Three towns and an abstract universal are not three connected towns. A doctrine of connectedness is wanted. Bradley * writes 'Is there, in the end, such a thing as a relation which is merely *between* terms? Or, on the other hand, does not a relation imply an underlying unity and an inclusive whole?'

Bradley's 'inclusive whole' is the connectedness of which we are in search. Throughout this chapter [*loc. cit.*] Bradley uses the term Feeling to express the primary activity at the basis of experience. It is experience itself in its origin and with the minimum of analysis. The analysis of Feeling can never disclose anything lying beyond the essence of the occasion of experience. Hence Bradley terms it 'non-relational'. There are of course grave differences between my own doctrine and that of Bradley. This was a reason for expounding my point of view in some independence of Bradley, with due acknowledgement. Surely the proper method of choosing technical terms is to adopt terms from some outstanding exposition of an analogous doctrine. It throws an interesting light on the belief in a well-understood technical phraseology reigning in philosophy, that an accomplished philosopher censured in print my use of the word Feeling as being in a sense never before employed in philosophy.

I may add that William James also employs the word in much the same sense in his *Psychology*. For example in the first chapter he writes, 'Sensation is the feeling of first things.' And in the second chapter he writes, 'In general, this higher consciousness about things is called Perception, the mere inarticulate feeling of their presence is Sensation, so far as we have it at all. To some degree we seem able to lapse into this inarticulate feeling at moments when our attention is entirely dispersed.' It is interesting to make a few citations from Bradley, illustrating my general adherence to his doctrine of Feeling, as expressed in his Chapter. 'In my general feeling at any moment there is more than the objects before me, and no perception of objects will exhaust the sense of a living emotion.' †

In accordance with this doctrine of Bradley's, I analyze a feeling [or prehension] into the 'datum', which is Bradley's 'object before me', into the 'subjective form' which is Bradley's 'living emotion',

* Cf. *Essays on Truth and Reality,* Ch. VI, *On Our Knowledge of Immediate Experience,* Appendix, p. 193.

The page references are to the Oxford edition of 1914. Also cf. Appendix to Ch. VI, *passim,* and Supplementary Note to the same.

† Bradley, p. 159.

and into the 'subject' which is Bradley's 'me'. My reason for using the term 'subjective form' is that I stretch its meaning beyond 'emotion.' For example consciousness, if it be present, is an element in the subjective form. This is, of course, a grave divergence from Bradley. Subjective form is the character assumed by the subject by reason of some prehended datum.

But on the whole I conform to Bradley's conception of the function of subjective form. For example, 'These puzzles are insoluble unless that which I feel, and which is not an object before me, is present and active. This felt element is used and it must be used in the constitution of that object which satisfies me.' *

From my point of view there is an ambiguity in this statement, but I adhere to either alternative meaning.

The component of feeling 'which is not an object before me' is the subjective form. If Bradley is stating that the subjective forms of feelings determine the process of integration, I entirely agree. The result, as Bradley states, is the 'satisfaction' which is the final feeling terminating the unrest of the creative process.

Bradley, however, may mean by his phrase 'that which I feel, and which is not an object before me' what I term a 'negative prehension'. Such a prehension is active *via* its contribution of its subjective form to the creative process, but it dismisses its 'object' from the possibility of entering into the datum of the final satisfaction. This final complex datum will be what Bradley calls 'that object that satisfies me'. Again I agree.

The doctrine of the 'living emotion' which necessarily clothes each concrete exhibition of the subject-object situation is far older than Bradley. We find its germ in Plato, who insists that the whole character is conformed to the adequate knowledge. He implicitly refuses to abstract the 'living emotion' from the bare intellectual perception, and thereby identifies virtue with knowledge. The advance in psychology has added to our conscious discrimination, but it has not altered the fact that inevitably perception is clothed with emotion.

The historical importance of the doctrine is stated by George Foot Moore: †—'Civilization develops only where considerable numbers of men work together for common ends. Such unity is brought about,

* Bradley, p. 161.

† In the *Prefatory Note to Emotion as the Basis of Civilization,* by J. H. Denison (New York, Scribner's, 1928): a work of importance.

not so much by community of bare ideas as by community of the feelings by which ideas are "emotionalized" and become beliefs and motives.'

The conventionalized abstractions prevalent in epistemological theory are very far from the concrete facts of experience. The word 'feeling' has the merit of preserving this double significance of subjective form and of the apprehension of an object. It avoids the *disjecta membra* provided by abstraction.*

SECTION XII. Thus an occasion of human experience is one illustration of the required doctrine of connectedness.

Bradley's authority can be quoted in support. He writes: † 'At every moment my stage of experience, whatever else it is, is a whole of which I am immediately aware. It is an experienced non-relational unity of many in one.' Here Bradley by 'non-relational' apparently means that experience is not a relation of an experient to something external to it, but is itself the 'inclusive whole' which is the required connectedness of 'many in one.'

In this I thoroughly agree, holding that the connectedness of things is nothing else than the togetherness of things in occasions of experience. Of course, such occasions are only rarely occasions of human experience.

Curiously enough Hume also agrees. For his only togetherness of the stream of impressions of sensation, which in his doctrine are distinct existences at distinct times, lies in the 'gentle force' of association which must lie wholly within an occasion of experience. This is also one aspect of Kant's doctrine, that the occasions of experience provide the forms of connectedness.

Of course there are important differences between all these doctrines. But they agree in their general principle—to look on occasions of experience as the ground of connectedness.

SECTION XIII. Also Leibniz can find no other connectedness between reals except that lying wholly within the individual experiences of the monads, including the Supreme Monad. He employed the terms 'perception' and 'apperception' for the lower and higher ways in which one monad can take account of another, namely for ways

* The genetic description of the process of 'emotionalization' is considered in my *'Symbolism, Its Meaning and Effect'* and also in *Process and Reality*, Pt. II, Ch. VIII, and throughout Pt. III.

† *Loc. cit.*, p. 175.

of awareness. But these terms are too closely allied to the notion of consciousness which in my doctrine is not a necessary accompaniment. Also they are all entangled in the notion of representative perception which I reject. But there is the term * 'apprehension' with the meaning of 'thorough understanding.' Accordingly, on the Leibnizian model, I use the term 'prehension' for the general way in which the occasion of experience can include, as part of its own essence, any other entity, whether another occasion of experience or an entity of another type. This term is devoid of suggestion either of consciousness or of representative perception. Feelings are the positive type of prehensions. In positive prehensions the 'datum' is preserved as part of the final complex object which 'satisfies' the process of self-formation and thereby completes the occasion.

This nomenclature has been made up to conform to the condition, that, as a theory develops, its technical phraseology should grow out of the usages of the great masters who laid its foundations. The immediate verbal usages at any moment prevalent in any school of philosophy are but a small selection from the total vocabulary of the philosophic tradition. This is rightly the case having regard to the variations of doctrine.

The current usage can express the doctrine of the reigning school of thought and of certain accredited variations from it. The demand that an alternative doctrine with other roots in the historic tradition should confine itself to this selection of terms amounts to the dogmatic claim that certain preliminary assumptions should never be revised. Only those schools of thought are to be allowed which can be expressed in the sacred terms. What can reasonably be asked, is that each doctrine should ground its vocabulary on its own proper tradition. If this precaution has been taken, an outcry as to neologisms is a measure of unconscious dogmatism.

Section XIV. The main method of philosophy in dealing with its evidence is that of descriptive generalization. Social institutions exemplify a welter of characteristics. No fact is merely such-and-such. It exemplifies many characters at once, all rooted in the specialities of its epoch. Philosophic generalization seizes on those characters of abiding importance, dismissing the trivial and the evanescent. There is an ascent from a particular fact, or from a species, to the genus exemplified.

* This term is used by L. T. Hobhouse, *Theory of Knowledge*, Chs. I and II.

It is to be noted that the converse procedure is impossible. There can be no descent from a mere genus to a particular fact, or to a species. For facts and species are the product of the mingling of genera. No genus in its own essence indicates the other genera with which it is compatible. For example, the notion of a backbone does not indicate the notions of suckling the young or of swimming in water. Thus no contemplation of the genus vertebrate, taken by itself, can suggest mammals or fishes, even as abstract possibilities. Neither the species nor the instance are to be discovered by the genus alone, since both include forms not 'given' by the genus. A species is a potential mingling of genera, and an individual instance involves, among other things, an actual mingling of many species. A syllogism is a scheme for demonstration of ways of mingling.

Thus the business of Logic is not the analysis of generalities but their mingling.*

Philosophy is the ascent to the generalities with the view of understanding their possibilities of combination. The discovery of new generalities thus adds to the fruitfulness of those already known. It lifts into view new possibilities of combination.

SECTION XV. Even the dim apprehension of some great principle is apt to clothe itself with tremendous emotional force. The welter of particular actions arising out of such complex feelings with their core of deep intuition are in primitive times often brutish and nasty. Finally civilized language provides a whole group of words, each embodying the general idea under its own specialization. If we desire to reach the generality common to these various specializations, we must gather together the whole group of words with the hope of discerning their common element. This is a necessary procedure for the purpose of philosophical generalization. The premature use of one familiar word inevitably limits the required generalization by importing the familiar special connotation of that word.

For example, let the working hypothesis be that the ultimate realities are the events in their process of origination. Then each event, viewed in its separate individuality, is a passage between two ideal termini, namely, its components in their ideal disjunctive diversity passing into these same components in their concrete togetherness. There are two current doctrines as to this process. One is that of the external Creator, eliciting this final togetherness out of nothing. The

* Cf. Plato's *Sophist*, 253.

other doctrine is that it is a metaphysical principle belonging to the nature of things, that there is nothing in the Universe other than instances of this passage and components of these instances. Let this latter doctrine be adopted. Then the word Creativity expresses the notion that each event is a process issuing in novelty. Also if guarded in the phrases Immanent Creativity, or Self-Creativity, it avoids the implication of a transcendent Creator. But the mere word Creativity suggests Creator, so that the whole doctrine acquires an air of paradox, or of pantheism. Still it does convey the origination of novelty. The word Concrescence is a derivative from the familiar Latin verb, meaning 'growing together'. It also has the advantage that the participle 'concrete' is familiarly used for the notion of complete physical reality. Thus Concrescence is useful to convey the notion of many things acquiring complete complex unity. But it fails to suggest the creative novelty involved. For example, it omits the notion of the individual character arising in the concrescence of the aboriginal data. The event is not suggested as 'emotionalized', that is, as with its 'subjective form.'

Again the term 'together' is one of the most misused terms in philosophy. It is a generic term illustrated by an endless variety of species. Thus its use as though it conveyed one definite meaning in diverse illustrations is entirely sophistical. Every meaning of 'together' is to be found in various stages of analysis of occasions of experience. No things are 'together' except in experience; and no things *are,* in any sense of 'are', except as components in experience or as immediacies of process which are occasions in self-creation.

Section XVI. Thus to arrive at the philosophic generalization which is the notion of a final actuality conceived in the guise of a generalization of an act of experience, an apparent redundancy of terms is required. The words correct each other. We require * 'together', 'creativity', 'concrescence', 'prehension', 'feeling', 'subjective form', 'data', 'actuality', 'becoming', 'process'.

Section XVII. At this stage of the generalization a new train of thought arises. Events become and perish. In their becoming they are immediate and then vanish into the past. They are gone; they have perished; they are no more and have passed into not-being. Plato terms † them things that are 'always becoming and never really

* Cf. *Process and Reality, passim,* also *Science and the Modern World.*
† Cf. *Timaeus.*

are'. But before he wrote this phrase, Plato had made his great metaphysical generalization, a discovery which forms the basis of the present discussion. He wrote in the *Sophist,* 'not-being is itself a form of being'. He only applied this doctrine to his eternal forms. He should have applied the same doctrine to the things that perish. He would then have illustrated another aspect of the method of philosophic generalization. When a general idea has been obtained, it should not be arbitrarily limited to the topic of its origination.

In framing a philosophic scheme, each metaphysical notion should be given the widest extension of which it seems capable. It is only in this way that the true adjustment of ideas can be explored. More important even than Occam's doctrine of parsimony—if it be not another aspect of the same—is this doctrine that the scope of a metaphysical principle should not be limited otherwise than by the necessity of its meaning.

Thus we should balance Aristotle's—or, more rightly, Plato's—doctrine of becoming by a doctrine of perishing. When they perish, occasions pass from the immediacy of being into the not-being of immediacy. But that does not mean that they are nothing. They remain 'stubborn fact':—

Pereunt et imputantur.

The common expressions of mankind fashion the past for us in three aspects—causation, memory, and our active transformation of our immediate past experience into the basis of our present modification of it. Thus 'perishing' is the assumption of a rôle in a transcendent future. The not-being of occasions is their 'objective immortality'. A pure physical prehension is how an occasion in its immediacy of being absorbs another occasion which has passed into the objective immortality of its not-being. It is how the past lives in the present. It is causation. It is memory. It is perception of derivation. It is emotional conformation to a given situation, an emotional continuity of past with present. It is a basic element from which springs the self-creation of each temporal occasion. Thus perishing is the initiation of becoming. How the past perishes is how the future becomes.

Modes of Thought

II. Activity

Lecture Five Forms of Process 861

Lecture Six Civilized Universe 875

III. Nature and Life

Lecture Seven Nature Lifeless 890

Lecture Eight Nature Alive 905

IV. Epilogue

Lecture Nine The Aim of Philosophy 921

MODES OF THOUGHT

The nine lectures which compose the volume Modes of Thought, published in 1938, come from three different sources. The first six formed a series of lectures at Wellesley College—the last series Whitehead gave—and the fifth and sixth of these are included in this anthology.

Lectures Seven and Eight were originally published under the title Nature and Life, after being delivered at the University of Chicago in 1933. They constitute a succinct expression of the contrast which Whitehead often developed between his philosophy and the prevailing philosophy of the seventeenth and eighteenth centuries.

The final chapter, an epilogue, was a brief address which was given in 1935 before the members of the Harvard Philosophy Department and their graduate students at their annual reception.

II. Activity

LECTURE FIVE *FORMS OF PROCESS*

The topic of this, and of the next, lecture originates in the consideration of the various modes of unity exhibited by compositions within the historic world. Examples of such organizations are throbs of pulsation, molecules, stones, lives of plants, lives of animals, lives of men. The discussion then passes into the vaguer forms of unity, such as sociology in its widest meaning, laws of nature, spatio-temporal connections.

The argument passes to the consideration of that final mode of unity in virtue of which there exists stability of aim amid the multiple forms of potentiality, and in virtue of which there exists importance beyond the finite importance for the finite actuality. In other words, How does importance for the finite require importance for the infinite?

In this connection, Descartes discusses Perfection. He chose a notion which is too limited and too ambiguous. He slipped into his discussion a false premise, namely, that one final perfection with static existence constitutes a notion which is relevant to our experience. He should have taken the wider notion of Importance. In what sense is there 'importance for the universe'? Does not 'importance for the finite' involve the notion of 'importance for the infinite'?

2. The first point to make is the transition from accident towards necessity as we pass from the smaller to the larger units of composition. There is a large element of accident in a single sentence of a lecture. The lecture as a whole reflects with some necessity the character of the lecturer as he composes it. The character of the lecturer arises from the moulding it receives from the social circumstances of his whole life. These social circumstances depend on the historic epoch, and this epoch is derivative from the evolution of life on this planet. Life on this planet depends on the order observed throughout the spatio-temporal stellar system, as disclosed in our experience. These special forms of order exhibit no final necessity

whatsoever. The laws of nature are forms of activity which happen to prevail within the vast epoch of activity which we dimly discern. A problem now arises. There are forms of order with vast extension throughout time. There is no necessity in their nature. But there is necessity that the importance of experience requires adequate stability of order. Complete confusion can be equated with complete frustration. And yet the transitions of history exhibit transitions of forms of order. Epoch gives way to epoch. If we insist on construing the new epoch in terms of the forms of order in its predecessor we see mere confusion. Also there is no sharp division. There are always forms of order partially dominant, and partially frustrated. Order is never complete; frustration is never complete. There is transition within the dominant order; and there is transition to new forms of dominant order. Such transition is a frustration of the prevalent dominance. And yet it is the realization of that vibrant novelty which elicits the excitement of life.

The essence of life is to be found in the frustrations of established order. The Universe refuses the deadening influence of complete conformity. And yet in its refusal, it passes towards novel order as a primary requisite for important experience. We have to explain the aim at forms of order, and the aim at novelty of order, and the measure of success, and the measure of failure. Apart from some understanding, however dim, of these characteristics of the historic process, we enjoy no rationality of experience.

The development of western philosophy has been hampered by the tacit presupposition of the necessity of static spatio-temporal and physical forms of order. The development of scientific knowledge in the last two hundred years has completely swept away any ground for the assumption of such necessity. But the presupposition remains even among men of science. It is a tacit presupposition, among those who explicitly deny it. In current literature we find the same authors denying infractions of natural order, and denying any reason for such denial, and denying any justification for a philosophical search for reasons justifying their own denials.

What we have to explain is the trend towards order which is the overwhelming deliverance of experience. What we have also to explain is the frustration of order, and the absence of necessity in any particular form of order.

3. We must first examine the notion of Process. The compre-

hension of this notion requires an analysis of the interweaving of data, form, transition, and issue. There is a rhythm of process whereby creation produces natural pulsation, each pulsation forming a natural unit of historic fact. In this way, amid the infinitude of the connected universe, we can discern vaguely finite units of fact. If process be fundamental to actuality, then each ultimate individual fact must be describable as process. The Newtonian description of matter abstracts matter from time. It conceives matter 'at an instant.' So does Descartes' description. If process be fundamental such abstraction is erroneous.

We have now to consider in more detail this interweaving of data, form, transition, and issue which characterizes each unit of fact. We must however proceed by violent abstraction. Each fully realized fact has an infinitude of relations in the historic world and in the realm of form; namely, its perspective of the universe. We can only conceive it with respect to a minute selection of these relations. These relations, thus abstracted, require for their full understanding the infinitude from which we abstract. We experience more than we can analyze. For we experience the universe, and we analyze in our consciousness a minute selection of its details.

The data for any one pulsation of actuality consist of the full content of the antecedent universe as it exists in relevance to that pulsation. They are this universe conceived in its multiplicity of details. These multiplicities are antecedent pulsations, and also there are the variety of forms harboured in the nature of things, either as realized form or as potentialities for realization. Thus the data consist in what has been, what might have been, and what may be. And in these phrases the verb 'to be' means some mode of relevance to historic actualities.

Such are the data; and from these data there emerges a process with a form of transition. This unit of process is the 'specious present' of the actuality in question. It is a process of composition, of gradation, and of elimination. Every detail in the process of being actual involves its own gradation in reference to the other details. The effectiveness of any one such factor involves the elimination of elements in the data not to be reconciled with that detail playing that part in the process. Now elimination is a positive fact, so that the background of discarded data adds a tone of feeling to the whole pulsation. No fact of history, personal or social, is understood until we know

what it has escaped and the narrowness of the escape. You cannot fully understand the history of the European races in North America, without reference to the double failure of Spanish domination over California in the nineteenth century, and over England in the sixteenth century.

All actuality involves the realization of form derived from factual data. It is both a composition of qualities, and it is also a form of composition. The form of composition dictates how those forms as thus realized in the data enter into a finite process of composition, thus achieving new actuality with its own exemplifications and discards. There is a form of process dealing with a complex form of data and issuing into a novel completion of actuality. But no actuality is a static fact. The historic character of the universe belongs to its essence. The completed fact is only to be understood as taking its place among the active data forming the future.

When we consider the process under examination as completed, we are already analysing an active datum for other creations. The universe is not a museum with its specimens in glass cases. Nor is the universe a perfectly drilled regiment with its ranks in step, marching forward with undisturbed poise. Such notions belong to the fable of modern science—a very useful fable when understood for what it is. Science deals with large average effects, important within certain modes of observation. But in the history of human thought no scientific conclusion has ever survived unmodified by radical increase in our subtleties of relevant knowledge.

4. In order to examine the notion of a form of transition, we will dwell on its simplest example. Consider arithmetic as being concerned with special forms of process. We shall here be contradicting the fashionable notion of 'tautology.' Conceive the fusion of two groups, each characterized by triplicity, into a single group. The whole essence of the notion of 'twice-three' is process, and 'twice-three' expresses its special form of process. This form derives its peculiar character from two sources. One source is the triplicity of each of the two groups in process of fusion. This triplicity arises from some principle of individuation dominating the process of aggregation of each group. As a result of this principle, each group exemplifies three-ness. There is then a process of fusion of both groups into one. We are considering the characterization of this resultant group in terms of number. It is not true that this process

of fusion necessarily issues in a group of six, in which the same principle of identifying individual things is preserved.

For example, consider drops of water, each drop with its own skin of surface-tension. Let there be two groups, each of three drops. The process of fusion may result in coalescence so that one drop results; or it may result in shattering the original drops, so that a group of fifty drops appears. The process, normally presupposed in the phrase 'twice-three,' is such that the relevant principle of individuation is kept undisturbed. In such a case, twice-three is six. But this phrase 'principle of individuation' has a vague interpretation. A doctor orders a dose of two teaspoonfuls. The dose is in fact taken in one desert spoon. Thus the actual individuation into teaspoons may be unimportant, and may never be achieved.

The statement 'twice-three is six' is referent to an unspecified principle of sustenance of character which is supposed to be maintained during the process of fusion. The phrase 'twice-three' refers to a form of process of fusion sustaining this principle of individuation. Putting this in a more general statement, arithmetical phrases refer to special forms of process, issuing in a group characterized by some definite arithmetical character. The process has its strict form, and in the circumstances mentioned it issues in a complex entity with that character.

I am sorry to insist on this triviality at such wearisome length. Perhaps some of you will have recognized that I am contradicting a widespread belief. A prevalent modern doctrine is that the phrase 'twice-three is six' is a tautology. This means that 'twice-three' says the same thing as 'six'; so that no new truth is arrived at in the sentence. My contention is that the sentence considers a process and its issue. Of course, the issue of one process is part of the material for processes beyond itself. But in respect to the abstraction 'twice-three is six,' the phrase 'twice-three' indicates a form of fluent process and 'six' indicates a characterization of the completed fact.

We are naïve in our interpretation of language and of symbolism. We neglect subtle differences of meaning. If we say that 'six is not equal to seven,' we are denying the identity of 'six' and 'seven.' In this phrase, the word 'equality' means 'identity.' If we say that 'twice-three is six,' we are saying that the issue of a process is an entity with the character 'six.' If we are saying that 'twice-three is equal to the sum of two and four,' we are saying that two distinct

processes issue in compositions with the same numerical character. The meanings of 'equality'—or of the word 'is'—differ in each of these cases. My final point is that mathematics is concerned with certain forms of process issuing into forms which are components for further process. In the previous lecture, we noted that the concept of a form of process gave its meaning to the concept of an infinite series, as employed in mathematics.

This discussion is a belated reminder to Plato that his eternal mathematical forms are essentially referent to process. This is his own doctrine when he refers to the necessity of 'life and motion.' But only intermittently did he keep it in mind. He was apt to identify process with mere appearance, and to conceive of absolute reality as devoid of transition. For him, in this mood, mathematics belonged to changeless eternity. He then has accepted 'tautology.'

5. The nature of any type of existence can only be explained by reference to its implication in creative activity, essentially involving three factors: namely, data, process with its form relevant to these data, and issue into datum for further process—data, process, issue.

The alternative is the reduction of the universe to a barren tautological absolute, with a dream of life and motion. The discovery of mathematics, like all discoveries, both advanced human understanding, and also produced novel modes of error. Its error was the introduction of the doctrine of form, devoid of 'life and motion.'

The 'supreme being' of Greek philosophy was conceived by thinkers under the influence of the then recent development of mathematics, when the active-minded Greeks came into contact with Egyptian thought. They misconceived the relevance of mathematical notions. All mathematical notions have reference to a process of intermingling. The very notion of number refers to the process from the individual units to the compound group. The final number belongs to no one of the units; it characterizes the way in which the group unity has been attained. Thus even the statement 'six equals six' need not be construed as a mere tautology. It can be taken to mean that six as dominating a special form of combination issues in six as a character of a datum for further process. There is no such entity as a mere static number. There are only numbers playing their parts in various processes conceived in abstraction from the world-process.

The notion of the world-process is therefore to be conceived as the

notion of the totality of process. The notion of a supreme being must apply to an actuality in process of composition, an actuality not confined to the data of any special epoch in the historic field. Its actuality is founded on the infinitude of its conceptual appetition, and its form of process is derived from the fusion of this appetition with the data received from the world-process. Its function in the world is to sustain the aim at vivid experience. It is the reservoir of potentiality and the coördination of achievement. The form of its process is relevant to the data from which the process is initiated. The issue is the unified composition which assumes its function as a datum operative in the future historic world.

The data of our experience are of two kinds. They can be analysed into realized matter-of-fact and into potentialities for matter-of-fact. Further, these potentialities can be analysed into pure abstract potentialities apart from special relevance to realization in the data or the issue, and into potentialities entertained by reason of some closeness of relevance to such realization. These potentialities entertained in respect to their close relevance are the agents dictating the form of composition which produces the issue. This dictation of a form of composition involves the birth of an energetic determination whereby the data are subject to preservation and discard.

In so far as there is large mutual conformity in the data, the energetic form of composition is such as to transmit this conformity to the issue, thereby preserving that uniformity for the future. We have here the basis of the large scale preservation of identities, amid minor changes. The planets, the stones, the living things all witness to the wide preservation of identity. But equally they witness to the partiality of such preservation. Nothing in realized matter-of-fact retains complete identity with its antecedent self. This self-identity in the sphere of realized fact is only partial. It holds for certain purposes. It dominates certain kinds of process. But in other sorts of process, the differences are important, and the self-identity is an interesting fable. For the purpose of inheriting real estate, the identity of the man of thirty years of age with the former baby of ten months is dominant. For the purpose of navigating a yacht, the differences between the man and the child are essential; the identity then sinks into a metaphysical irrelevancy. In so far as identities are preserved, there are orderly laws of nature. In so far as identities decay, these laws are subject to modification. But the modification itself may

be lawful. The change in the individual may exhibit a law of change, as, for example, the change from baby to fully-grown animal. And yet such laws of change are themselves liable to change. For example, species flourish and decay; civilizations rise and fall; heavenly bodies gradually form, and pass through sequences of stages.

In any of these examples, as the changes occur, new types of existence are rendered possible, subject to new laws of nature dependent upon that new environment. In other words, the data, the forms of process, and the issues into new data, are all dependent upon their epoch and upon the forms of process dominant in that epoch.

Nothing is more interesting to watch than the emotional disturbance produced by any unusual disturbance of the forms of process. The slow drift is accepted. But when for human experience quick changes arrive, human nature passes into hysteria. For example, gales, thunderstorms, earthquakes, revolutions in social habits, violent illnesses, destructive fires, battles, are all occasions of special excitement. There are perfectly good reasons for this energetic reaction to quick change. My point is the exhibition of our emotional reactions to the dominance of lawful order, and to the breakdown of such order. When fundamental change arrives, sometimes heaven dawns, sometimes hell yawns open.

6. Too much attention has been directed to the mere datum and the mere issue. The essence of existence lies in the transition from datum to issue. This is the process of self-determination. We must not conceive of a dead datum with passive form. The datum is impressing itself upon this process, conditioning its forms. We must not dwell mainly on the issue. The immediacy of existence is then past and over. The vividness of life lies in the transition, with its forms aiming at the issue. Actuality in its essence is aim at self-formation.

One main doctrine, developed in these lectures, is that 'existence' (in any of its senses) cannot be abstracted from 'process.' The notions of 'process' and 'existence' presuppose each other. One deduction from this thesis is that the notion of a 'point' in process is fallacious. The concept of 'point' is here meant to imply that process can be analysed into compositions of final realities, themselves devoid of process.

For example, consider the notion of a moment of time devoid of any temporal spread—for example, at noon on such-and-such a day.

Such a notion is the concept of a point devoid of process. Again, a point in space is another such example. On the contrary, the extension of space is the ghost of transition. It is only to be experienced by some process of transition. This truth has, within the last thirty years, conquered modern physics in the somewhat naïve form of doctrines about light.

The general principle, underlying these special cases, is that the erroneous notions of process devoid of individualities, and of individualities devoid of process, can never be adjusted to each other. If you start with either of these falsehoods, you must dismiss the other as meaningless.

The notion of number, as elaborated in arithmetic, has been traditionally treated with this bias towards such an erroneous separation. Each individual thing is devoid of numerosity; whereas, a static group is characterized by number. In this way process seems to be absent in our treatment of arithmetic. Thus mathematics has been conceived as the test case, which is the citadel for a false metaphysics.

When Plato thought of mathematics he conceived of a changeless world of form, and contrasted it with the mere imitation in the world of transition. Yet when Plato thought of the realities of action, he swayed to the opposite point of view. He called for 'life and motion' to rescue forms from a meaningless void.

In these lectures Plato's second doctrine, of life and motion, has been adopted. The mathematical modes of fusion, such as 'addition,' 'multiplication,' 'serial form,' and so on, have been construed as forms of process. The very notion of 'multiplicity' itself has been construed as abstraction from the form of process whereby data acquire a unity of issue into a novel datum.

7. Process and individuality require each other. In separation all meaning evaporates. The form of process (or, in other words, the appetition) derives its character from the individuals involved, and the characters of the individuals can only be understood in terms of the process in which they are implicated.

A difficult problem arises from this doctrine. How can the notion of any generality of reasoning be justified? For if the process depends on the individuals, then with different individuals the form of process differs. Accordingly, what has been said of one process cannot be said of another process. The same difficulty applies to the

notion of the identity of an individual conceived as involved in different processes. Our doctrine seems to have destroyed the very basis of rationality.

The point is that every individual thing infects any process in which it is involved, and thus any process cannot be considered in abstraction from particular things involved. Also the converse holds. Hence the absolute generality of logic and of mathematics vanishes. Also induction loses any security. For in other circumstances, there will be other results.

In approaching this problem, the first point to notice is that its difficulty is in accordance with common sense. The distinctions between various sciences, and various topics for study, illustrate this point. No one would study geology as a preparation for appreciation of the sonnets of Shakespeare or the fugues of Bach. The things discussed in geology are so different from sonnets and so different from fugues. The result is that the interconnections discussed in a treatise on geology are very different from those disclosed in the structure of a sonnet or of a fugue. But faint analogies do occur. Sometimes these analogies rise in importance. For example, the Greeks discovered analogies between the lengths of strings and the harmonies of musical notes, and between the measurements of the dimensions of a building and the beauty of the structure.

Thus the differences arising from diversities are not absolute. Analogies survive amid diversity. The procedure of rationalism is the discussion of analogy. The limitation of rationalism is the inescapable diversity. The development of civilized thought can be described as the discovery of identities amid diversity. For example, the discovery of identities of number as between a group of days and a group of fishes.

The whole understanding of the world consists in the analysis of process in terms of the identities and diversities of the individuals involved. The peculiarities of the individuals are reflected in the peculiarities of the common process which is their interconnection. We can start our investigation from either end; namely, we can understand the process and thence consider the characterization of the individuals; or we can characterize the individuals and conceive them as formative of the relevant process. In truth, the distinction is only one of emphasis.

But this possibility of abstraction, whereby individuals and the

forms of process constituting their existence can be considered separately, brings out a fundamental intuition which lies at the basis of all thought. This intuition consists in the essential passage from experience of individual fact to the conception of character. Thence we proceed to the concept of the stability of character amidst the succession of facts. Thence we proceed to the concept of the partial identity of successive facts in a given route of succession. Thence we proceed to the potentiality of the facts for maintaining such partial identity amid such succession.

In other words, as soon as we abstract, so as to separate the notions of serial forms and of individual facts involved, we necessarily introduce the notion of potentiality: namely, the potentiality of the facts for the series and of the series for the facts. All our knowledge consists in conceiving possible adjustments of series and of individual facts to each other. We say in effect, such and such facts are consistent with such and such serial forms. We are considering possibilities for individuals and possibilities for series. The mere immediate exemplification is only one aspect of our experience.

8. The notion of potentiality is fundamental for the understanding of existence, as soon as the notion of process is admitted. If the universe be interpreted in terms of static actuality, then potentiality vanishes. Everything is just what it is. Succession is mere appearance, rising from the limitation of perception. But if we start with process as fundamental, then the actualities of the present are deriving their characters from the process, and are bestowing their characters upon the future. Immediacy is the realization of the potentialities of the past, and is the storehouse of the potentialities of the future. Hope and fear, joy and disillusion, obtain their meaning from the potentialities essential in the nature of things. We are following a trail in hope, or are fleeing from the pursuit in fear. The potentialities in immediate fact constitute the driving force of process.

At this point the discussion must be halted. It has run into exaggeration. The essence of the universe is more than process. The alternative metaphysical doctrine, of reality devoid of process, would never have held the belief of great men, unless it expressed some fundamental aspect of our experience. For example, Newton's belief in absolute space may be mistaken. All the same it bears witness to the fact of the obviousness to him of factors in the universe to which the notion of process does not apply. At least the potentiality of

spatial relations among the realizations of history stood for him as a timeless fact. He did not state it in this way. This formulation tones down his own belief in the independent actuality of space.

But as expressed in this way, the notion of spatial relations is an example of connected forms with overwhelming relevance to the present epoch of history. Also it illustrates the main principle on which Induction is based. This principle is that form of process chiefly derives from the dominant facts involved and thence tends to sustain itself so as to govern realizations in its own future. This is the doctrine of the varying relevance of potential forms. Thus the doctrine of the potentiality of the present to characterize the realizations of the future lies hidden in the beliefs of Bacon and of Newton. It is the sense of the form having a dual activity in the present. It characterizes the present and it thereby fashions the form of process in the future.

Two other names must be added: Plato with his supreme realm of forms, and Leibniz with his monads each with its form of process. Leibniz's doctrine is curiously reminiscent of Descartes' science of Analytical Geometry with its curves, each expressed by an algebraic equation, which is the form for the description of the curve. The difficulty is to relate the static form to the active process. There is an analogous difficulty in relating the static immediacy of fact to the historic process with its past and its future. There is the further problem to express the interconnections of facts, each with its measure of self-sufficiency. Each fact is just that limited thing that it is. How then do facts require each other? Finally, each immediate fact is a realization of itself. In what sense, then, can a fact harbour potentiality, which is the capacity of form for realization? In other words, How can the realization of form involve in its own nature reference to the realization of other forms in other occasions?

The topics thus enumerated are generalized statements of the commonplaces of experience. They merely express what of course our lives mean to us in every moment of experience. For this very reason language fails in its analysis. We do not have to indicate for each other the necessities of existence. Language mainly presupposes the necessities and emphasizes the accidents. We rarely mention what must be present. We do mention what might be absent. The whole difficulty of philosophic discussion is this feebleness of language. The title of one outstanding philosophic treatise in the English

language, belonging to the generation now passing, is *Space, Time, and Deity*. By this phrase, Samuel Alexander places before us the problem which haunts the serious thought of mankind. Time refers to the transitions of process, Space refers to the static necessity of each form of interwoven existence, and Deity expresses the lure of the ideal which is the potentiality beyond immediate fact.

9. Apart from Time there is no meaning for purpose, hope, fear, energy. If there be no historic process, then everything is what it is, namely, a mere fact. Life and motion are lost. Apart from Space, there is no consummation. Space expresses the halt for attainment. It symbolizes the complexity of immediate realization. It is the fact of accomplishment. Time and Space express the universe as including the essence of transition and the success of achievement. The transition is real, and the achievement is real. The difficulty is for language to express one of them without explaining away the other.

Finally, there is Deity, which is that factor in the universe whereby there is importance, value, and ideal beyond the actual. It is by reference of the spatial immediacies to the ideals of Deity that the sense of worth beyond ourselves arises. The unity of a transcendent universe, and the multiplicity of realized actualities, both enter into our experience by this sense of Deity. Apart from this sense of transcendent worth, the otherness of reality would not enter into our consciousness. There must be value beyond ourselves. Otherwise every thing experienced would be merely a barren detail in our own solipsist mode of existence. We owe to the sense of Deity the obviousness of the many actualities of the world, and the obviousness of the unity of the world for the preservation of the values realized and for the transition to ideals beyond realized fact.

Thus, Space, Time, and Deity are general terms which indicate three types of reflective notions. The understanding of the nature of things in terms of such concepts is what distinguishes the human species from the other animals. The distinction is not absolute. The higher animals show every sign of understandings and of devotions which pass beyond the immediate enjoyments of immediate fact. Also the life of each human being is mainly a dumb passage from immediacy to immediacy devoid of the illumination of higher reflection. But when all analogies between animal life and human nature have been stressed, there remains the vast gap in respect to the influence of reflective experience. This reflective experience

exhibits three main characteristics which require each other for their full understanding. There are the experiences of joint association, which are the spatial experiences. There are the experiences of origination from a past and of determination towards a future. These are temporal experiences.

There are experiences of ideals—of ideals entertained, of ideals aimed at, of ideals achieved, of ideals defaced. This is the experience of the Deity of the universe. The intertwining of success and failure in respect to this final experience is essential. We thereby experience a relationship to a universe other than ourselves. We are essentially measuring ourselves in respect to what we are not. A solipsist experience cannot succeed or fail, for it would be all that exists. There would be no standard of comparison. Human experience explicitly relates itself to an external standard. The universe is thus understood as including a source of ideals.

The effective aspect of this source is Deity as immanent in the present experience. The sense of historic importance is the intuition of the universe as everlasting process, unfading in its deistic unity of ideals.

Thus there is an essential relevance between Deity and historic process. For this reason, the form of process is not wholly dependent upon derivation from the past. As epochs decay amid futility and frustration, the form of process derives other ideals involving novel forms of order.

Science investigates the past, and predicts the future in terms of the forms of past achievement. But as the present becomes self-destructive of its inherited modes of importance, then the Deistic influence implants in the historic process new aims at other ideals.

Science is concerned with the facts of bygone transition. History relates the aim at ideals. And between Science and History, lies the operation of the Deistic impulse of energy. It is the religious impulse in the world which transforms the dead facts of Science into the living drama of History. For this reason Science can never foretell the perpetual novelty of History.

LECTURE SIX *CIVILIZED UNIVERSE*

In this lecture we seek the evidence for that conception of the universe which is the justification for the ideals characterizing the civilized phases of human society.

We have been assuming as self-evident the many actualities, their forms of coördination in the historic process, their separate importance, and their joint importance for the universe in its unity. It must be clearly understood, as stated in the earlier lectures, that we are not arguing from well-defined premises. Philosophy is the search for premises. It is not deduction. Such deductions as occur are for the purpose of testing the starting-points by the evidence of the conclusions.

A special science takes the philosophic assumptions and transforms them into comparative clarity by narrowing them to the forms of the special topic in question. Also even in reasoning thus limited to special topics, there is no absolute conclusiveness in the deductive logic. The premises have assumed their limited clarity by reason of presuming the irrelevance of considerations extraneous to the assigned topic. The premises are conceived in the simplicity of their individual isolation. But there can be no logical test for the possibility that deductive procedure, leading to the elaboration of compositions, may introduce into relevance considerations from which the primitive notions of the topic have been abstracted. The mutual conformity of the various perspectives can never be adequately determined.

The history of science is full of such examples of sciences bursting through the bounds of their original assumptions. Even in pure abstract logic as applied to arithmetic, it has within the last half century been found necessary to introduce a doctrine of types in order to correct the omissions of the original premises.

Thus deductive logic has not the coercive supremacy which is conventionally conceded to it. When applied to concrete instances, it is a tentative procedure, finally to be judged by the self-evidence of its issues. This doctrine places philosophy on a pragmatic basis. But the meaning of 'pragmatism' must be given its widest extension. In much modern thought, it has been limited by arbitrary specialist

assumptions. There should be no pragmatic exclusion of self-evidence by dogmatic denial. Pragmatism is simply an appeal to that self-evidence which sustains itself in civilized experience. Thus pragmatism ultimately appeals to the wide self-evidence of civilization, and to the self-evidence of what we mean by 'civilization.'

Before we finally dismiss deductive logic, it is well to note the function of the 'variable' in logical reason. In this connection the term 'variable' is applied to a symbol, occurring in a propositional form which merely indicates any entity to which the propositional form can be validly applied, so as to constitute a determinate proposition. Also the variable, though undetermined, sustains its identity throughout the arguments. The notion originally assumed importance in algebra, in the familiar letters such as x, y, z indicating any numbers. It also appears somewhat tentatively in the Aristotelian syllogisms, where names such as 'Socrates,' indicate 'any man, the same throughout the argument.'

The use of the variable is to indicate the self-identity of some use of 'any' throughout a train of reasoning. For example in elementary algebra when x first appears it means 'any number.' But in that train of reasoning, the reappearance of x always means 'the same number' as in that original appearance. Thus the variable is an ingenious combination of the vagueness of 'any' with the definiteness of a particular indication.

In logical reasoning, which proceeds by the use of the variable, there are always two tacit presuppositions—one is that the definite symbols of composition can retain the same meaning as the reasoning elaborates novel compositions. The other presupposition is that this self-identity of each variable can be preserved when the variable is replaced by some definite instance. Complete self-identity can never be preserved in any advance to novelty. The only question is, as to whether the loss is relevant to the purposes of the argument. The baby in the cradle, and the grown man in middle age, are in some senses identical and in other senses diverse. Is the train of argument in its conclusions substantiated by the identity or vitiated by the diversity?

We thus dismiss deductive logic as a major instrument for metaphysical discussion. Such discussion is concerned with the eliciting of self-evidence. Apart from such self-evidence, deduction fails. Thus logic presupposes metaphysics.

2. What is the dominating insight whereby we presuppose ourselves as actualities within a world of actualities? There can be no argument from a purely subjective experience of qualitative details so as validly to infer a world of actualities coördinate with ourselves. A 'form of reception' will then be simply a mode of make-belief. In other words, a form of reception is reduced to an account of our solipsist existence. It describes our individual experience of a display of qualitative pattern. It gives an account of an activity within us. It gives no account of ourselves as activities among other activities. It misses the point that we know ourselves as creatures in a world of creatures. We are reduced to an enjoyment of mere appearance. With such assumptions there are no data for the insight into a world of many coördinated actualities.

In the discussion of our experience, the first point for notice is the superficial variability in our clear consciousness of qualitative detail. The decisive consciousness that *this* is red, and *that* is loud, and *this other* is square, results from an effort of concentration and elimination. Also it is never sustained. There is always a flickering variation, varied by large-scale transference of attention. Consciousness is an ever-shifting process of abstracting shifting quality from a massive process of essential existence. It emphasizes. And yet, if we forget the background, the result is triviality.

Concentration of attention on sheer qualitative detail can result in consciousness of mere succession of such detail. For example, we record a red-and-green pattern succeeded by a blue-and-grey pattern, the experience being closed by a clear bell-like sound. There is a qualitative subjective experience. That and nothing more. The whole meaningless. This is the result of obtaining a clear-cut experience by concentrating on the abstractions of consciousness.

But we are conscious of more than clarity. The importance of clarity does not arise until we have interpreted it in terms of the vast issues vaguely haunting the fullness of existence.

It is here that the prominent epistemology of the modern centuries has been so weak. It has interpreted the totality of experience as a mere reaction to an initial clarity of sensa. The result is that the reaction is limited to the data provided by the sensa. Such modern schools of philosophic thought can simply ask, What is the sensible emotional reaction to a red-and-green pattern, succeeded by a blue-and-grey pattern, succeeded by a clear bell-like sound? The answer is,

What you like, except you are a highbrow intellectual when you will follow the current reactions of Greenwich Village and Harvard, if you are American, and of Bloomsbury and Oxford, if you are English.

In other words, the mass of our moral, emotional, and purposive experience is rendered trivial and accidental. The whole notion of our massive experience conceived as a reaction to clearly envisaged details is fallacious. The relationship should be inverted. The details are a reaction to the totality. They add definition. They introduce powers of judgment. They exalt men above animals, and animals above vegetables, and vegetables beyond stones, always provided that they are kept in their proper relation to the soil from which they originate. They are interpretative and not originative. What is original is the vague totality.

Of course, the clarity of experience does originate further experience, by reason of its very clarity. But this origination is a secondary fact, and is not the basis of the whole. We enter the room already equipped with an active aesthetic experience, and we are charmed with the forms and colouring of the furniture. The sensory experience of the room adds vividness and point to an activity of feeling already possessed.

3. At the base of our existence is the sense of 'worth.' Now 'worth' essentially presupposes that which is 'worthy.' Here the notion of worth is not to be construed in a purely eulogistic sense. It is the sense of existence for its own sake, of existence which is its own justification, of existence with its own character.

The discrimination of detail is definitely a secondary process, which may or may not assume importance. There is the germ of discrimination, which may or may not flower into a varied experience. The dim decision is a large-scale judgment—namely, avoidance or maintenance. The stage of analysis into details, of which some are to be discarded, others are to be maintained, has not arrived. There is simply the large-scale feeling as to the totality—avoid it or maintain it.

Again the primitive stage of discrimination is not primarily qualitative. It is the vague grasp of reality, dissecting it into a three-fold scheme, namely, The Whole, That Other, and This-My-Self.

This is primarily a dim division. The sense of totality obscures the analysis into self and others. Also this division is primarily based on

the sense of existence as a value-experience. Namely, the total value-experience is discriminated into this value-experience and those value-experiences. There is the vague sense of many which are one; and of one which includes the many. Also there are two senses of the one—namely, the sense of the one which is all, and the sense of the one among the many.

The fundamental *basis* of this description is that our experience is a value-experience, expressing a vague sense of maintenance or discard; and that this value-experience differentiates itself in the sense of many existences with value-experience; and that this sense of the multiplicity of value-experiences again differentiates it into the totality of value-experience, and the many other value-experiences, and the egoistic value-experience. There is the feeling of the ego, the others, the totality. This is the vague, basic presentation of the differentiation of existence, in its enjoyment of discard and maintenance. We are, each of us, one among others; and all of us are embraced in the unity of the whole.

The basis of democracy is the common fact of value-experience, as constituting the essential nature of each pulsation of actuality. Everything has some value for itself, for others, and for the whole. This characterizes the meaning of actuality. By reason of this character, constituting reality, the conception of morals arises. We have no right to deface the value-experience which is the very essence of the universe. Existence, in its own nature, is the upholding of value-intensity. Also no unit can separate itself from the others, and from the whole. And yet each unit exists in its own right. It upholds value-intensity for itself, and this involves sharing value-intensity with the universe. Everything that in any sense exists has two sides, namely, its individual self and its signification in the universe. Also either of these aspects is a factor in the other.

So far, we have been considering the dim foundation of experience. In animal experience there supervenes a process of keen discrimination of quality. The sense-experiences, such as sight, sound, smell, taste, touch, and so on, are distinguished. Also within each such species of quality, clear distinctions are discerned, for example, red and green, distinctions of note, distinctions of taste.

With the rise of clear sensations relating themselves to the universe of value-feeling, the world of human experience is defined.

4. At this point, the preceding exposition must be reviewed. It is

evident that the current doctrine of epistemology has been completely inverted. This current doctrine culminated in the eighteenth century with Hume's *Treatise*. It bases itself upon the well-defined factors in our experience. Undoubtedly there are these sensa, such as sensations of colour, sound, and so on. It is then assumed that because they are definite, therefore they are fundamental.

The other factors in experiences are therefore to be construed as derivative, in the sense of owing their origin to these sensa. Emotions, aspirations, hopes, fears, love, and hate, intentions, and recollections are merely concerned with sensa. Apart from sensa, they would be non-existent.

This is the doctrine which in this lecture is being denied. The only mode of decision can be by an appeal to the self-evidence of experience. In Hume's *Treatise,* this appeal is the basis on which he founds his doctrine.

In opposition to Hume's interpretation of experience, the first point to notice is that these distinct sensa are the most variable elements in our lives. We can shut our eyes, or be permanently blind. None-the-less we are alive. We can be deaf. And yet we are alive. We can shift and transmute these details of experience almost at will.

Further, in the course of a day our experience varies with respect to its entertainment of sensa. We are wide-awake, we doze, we meditate, we sleep. There is nothing basic in the clarity of our entertainment of sensa. Also in the course of our lives, we start in the womb, in the cradle, and we gradually acquire the art of correlating our fundamental experience to the clarity of newly-acquired sensa.

Again, human beings are merely one species in the throng of existences. There are the animals, the vegetables, the microbes, the living cells, the inorganic physical activities. At the beginning of science, nature was surveyed as including diversities of species and genera, separated by impassable boundaries. Today the doctrine of evolution reigns. We need not necessarily conceive this doctrine as implying evolution upwards. What we do observe is the historic transition from species to species, and genera to genera. The qualitative experiences of the various animals seem to be vastly different; in some respects, more keenly felt than among human beings—for example, the sense of smell by some dogs. In other respects, there is reason to suspect a certain dimness of such experience in living things

with low types of bodily organization. And yet they react to the external world.

In other words, reaction to the environment is not in proportion to clarity of sensory experience. Any such doctrine would sweep away the whole of modern physical science as being expressed in terms of irrelevancies. Reaction does not depend upon sense-experience for its initiation.

Now confine the argument to human experience, which we know at first hand. This experience does not depend for its excellence simply upon clarity of sense-experience. The specialist in clarity sinks to an animal level—the hound for smell, the eagle for sight.

Human beings are amateurs in sense-experience. The direct, vivid clarity does not dominate so as to obscure the infinite variety involved in the composition of reality. The sense-experience is an abstraction which illustrates and stimulates the completeness of actuality. It increases importance. But the importance thus elicited is more than a colour-scheme of red, white, and blue. It involves the infinitude of actuality, hidden in its finitude of realization.

5. Descartes, following a tradition stretching back to the very origin of philosophy, derives a proof of the existence of God from the notion of perfection. His argument fails, because he abstracts God from the historic universe. Thus the conclusion depends upon meaningless phrases respecting the unknown. We and our relationships are in the universe.

The starting point of philosophy is the determination of that aspect of experience which most fully exhibits the universal necessities of existence. In answer to this problem Descartes gave the formula 'clarity and distinctness.' He thereby inevitably prepared the way for Hume in the next century. The immense value of the philosophic discussions produced by Descartes and by Hume, arises from the fact that neither of them consistently followed this formula. Undoubtedly the clear and distinct factors in human experience are the high grade sensa. We have been considering the reasons for the conclusion that these distinct sensory factors are comparatively superficial elements in our lives.

Nothing is more astonishing in the history of philosophic thought than the naïve way in which our association with our human bodies is assumed. The unity of man and his body is taken for granted.

Where does my body end and the external world begin? For example, my pen is external; my hand is part of my body; and my finger nails are part of my body. Also the breath as it passes in and out of my lungs from my mouth and throat fluctuates in its bodily relationship. Undoubtedly the body is very vaguely distinguishable from external nature. It is in fact merely one among other natural objects.

And yet, the unity 'body and mind' is the obvious complex which constitutes the one human being. Our bodily experience is the basis of existence. How is it to be characterized? In the first place, it is not primarily an experience of sense-data, in the clear and distinct sense of that term. The internal functioning of a healthy body provides singularly few sense-data, primarily associated with itself. When such sense-data appear, we send for a doctor. They are mostly aches and pains. And yet our feeling of bodily-unity is a primary experience. It is an experience so habitual and so completely a matter of course that we rarely mention it. No one ever says, Here am I, and I have brought my body with me.

In what does this intimacy of relationship consist? The body is the basis of our emotional and purposive experience. It determines the way in which we react to the clear sensa. It determines the fact that we enjoy sensa. But the eye-strain in sight is not the eye-sight. We see with our eyes; we do not see our eyes.

The body is that portion of nature with which each moment of human experience intimately coöperates. There is an inflow and outflow of factors between the bodily actuality and the human experience, so that each shares in the existence of the other. The human body provides our closest experience of the interplay of actualities in nature.

Ordinary language, and the sciences of physiology and psychology, supply the evidence. This evidence is three-fold: namely, the body is part of nature, the body supplies the basis of emotional and sensory activities, and the agitations of human experience pass into subsequent bodily functionings.

The body is that part of nature whose functionings are so coördinated as to be reciprocally coördinated with the functionings of the corresponding human experience. There is a transfer of types of agitation.

So long as nature was conceived in terms of the passive, instan-

taneous existence of bits of matter, according to Newton or Democritus, a difficulty arises. For there is an essential distinction between matter at an instant and the agitations of experience. But this conception of matter has now been swept away. Analogous notions of activity, and of forms of transition, apply to human experience and to the human body. Thus bodily activities and forms of experience can be construed in terms of each other. Also the body is part of nature. Thus we finally construe the world in terms of the type of activities disclosed in our intimate experience.

6. This conclusion must not be distorted. The fallacious notion of passive matter has by a reaction led to a distorted account of human experience. Human nature has been described in terms of its vivid accidents, and not of its existential essence. The description of its essence must apply to the unborn child, to the baby in its cradle, to the state of sleep, and to that vast background of feeling hardly touched by consciousness. Clear, conscious discrimination is an accident of human existence. It makes us human. But it does not make us exist. It is of the essence of our humanity. But it is an accident of our existence.

What is our primary experience which lies below and gives its meaning to our conscious analysis of qualitative detail? In our analysis of detail we are presupposing a background which supplies a meaning. These vivid accidents accentuate something which is already there. We require to describe that factor in our experience which, being a matter of course, does not enter prominently into conversation. There is no need to mention it. For this reason language is very ineffective for the exposition of metaphysics.

Our enjoyment of actuality is a realization of worth, good or bad. It is a value-experience. Its basic expression is—Have a care, here is something that matters! Yes—that is the best phrase—the primary glimmering of consciousness reveals, Something that matters.

This experience provokes attention, dim and, all but, subconscious. Attention yields a three-fold character in the 'Something that matters.' Totality, Externality, and Internality are the primary characterizations of 'that which matters.' They are not to be conceived as clear, analytic concepts. Experience awakes with these dim presuppositions to guide its rising clarity of detailed analysis. They are presuppositions in the sense of expressing the sort of obviousness which

experience exhibits. There is the totality of actual fact; there is the externality of many facts; there is the internality of this experiencing which lies within the totality.

These three divisions are on a level. No one in any sense precedes the other. There is the whole fact containing within itself my fact and the other facts. Also the dim meaning of fact—or actuality—is intrinsic importance for itself, for the others, and for the whole.

7. Of course all our terms of speech are too special, and refer too explicitly to higher stages of experience. For this reason, philosophy is analogous to imaginative art. It suggests meanings beyond its mere statements. On the whole, elaborate phrases enshrine the more primitive meanings.

Also as disclosure develops, facts disclose themselves as stages in the transitions of history. Importance reveals itself as transitions of emotion. My importance is my emotional worth now, embodying in itself derivations from the whole, and from the other facts, and embodying in itself reference to future creativity.

These embodiments both unify the many facts in the experiencing self, and at the same time differentiate these facts by their variety of reference to that self. Some facts have such closeness of reference to the immediate self that an intimate unity with them is claimed. In this way, the concept of self-identical enduring personal existence dawns. It is the concept of one person with many stages of existence. But the basis of all experience is this immediate stage of experiencing, which is myself now. Also the external facts, as disclosed in experiencing, tend more vaguely and flittingly to group themselves in the same way.

But the sense of importance is not exclusively referent to the experiencing self. It is exactly this vague sense which differentiates itself into the disclosure of the whole, the many, and the self. It is the importance of the others which melts into the importance of the self. Actuality is the self-enjoyment of importance. But this self-enjoyment has the character of the self-enjoyment of others melting into the enjoyment of the one self. The most explicit example of this is our realization of those other actualities, which we conceive as ourselves in our recent past, fusing their self-enjoyment with our immediate present. This is only the most vivid instance of the unity of the universe in each individual actuality.

The main point of this description is the concept of actuality as

something that matters, by reason of its own self-enjoyment, which includes enjoyment of others and transitions towards the future.

Qualitative discrimination now arrives in the formation of the completed experience. The variety of quality is infinite. Thus every description is narrowed by some specialty of quality which is unconsciously presupposed.

There is the dim qualification enjoyed by the lowest types of actuality. There are the clear, distinct qualities enjoyed in human experience. There is every stage in between, and there are numberless stages which human experience has never touched. Undoubtedly, if we may trust our memories of the variety of human experience, the discrimination of quality immensely increases the intensity of experience. The sense of importance is a function of the analysis of experienced quality. It is hardly too much to say this. But it is too much; or rather, it is too simple an explanation. It does seem invariably the case, that the intrinsic importance of an experience requires a large clarity of analysis for one of its factors. Here the phrase 'intrinsic importance' means 'importance for itself.'

But the whole point of this exposition is that our discrimination is exercised upon an experienced world. This world is the subject-matter for qualitative discrimination. Civilization involves the understanding of the given world in respect to its qualifications.

8. This doctrine exactly inverts Hume's point of view, and the variant points of view derived from his doctrines. Hume makes the qualifications primary; and the world is introduced as a secondary conjecture. It is to be noticed that our exposition is nothing else than the expansion of the insight that 'power' is the basis of our notions of 'substance.' This notion of 'power' is to be found in Locke and in Plato, flittingly expressed and never developed. Our experience starts with a sense of power, and proceeds to the discrimination of individualities and their qualities.

Another consequence is that 'actuality' is in its essence 'composition.' Power is the compulsion of composition. Every other type of composition is a half-way stage in the attainment of actuality. The final actuality has the unity of power. The essence of power is the drive towards aesthetic worth for its own sake. All power is a derivative from this fact of composition attaining worth for itself. There is no other fact. Power and Importance are aspects of this fact. It constitutes the drive of the universe. It is efficient cause, maintaining

its power of survival. It is final cause, maintaining in the creature its appetition for creation.

The sense of externality is based on the primary self-analysis of the process of composition. This analysis discloses factors in the composition, with their own self-enjoyment and contributing that self-enjoyment to the immediate composition in which they are factors.

There are two types of such factors. In one type there are the many factors which form the historic environment for the new creation in the historic process. They are factors in the new composition which in its completion is one of themselves. This is a primary deliverance of experience, and if philosophical dictionaries have no single words to express it—so much the worse for the dictionaries.

9. The second type of factor has, by the nature of the case, only one example. It is that factor disclosed in our sense of the value, for its own sake, of the totality of historic fact in respect to its essential unity. There is a unity in the universe, enjoying value and (by its immanence) sharing value. For example, take the subtle beauty of a flower in some isolated glade of a primeval forest. No animal has ever had the subtlety of experience to enjoy its full beauty. And yet this beauty is a grand fact in the universe. When we survey nature and think however flitting and superficial has been the animal enjoyment of its wonders, and when we realize how incapable the separate cells and pulsations of each flower are of enjoying the total effect—then our sense of the value of the details for the totality dawns upon our consciousness. This is the intuition of holiness, the intuition of the sacred, which is at the foundation of all religion. In every advancing civilization this sense of sacredness has found vigorous expression. It tends to retire into a recessive factor in experience, as each phase of civilization enters upon its decay.

We are now discussing an alternative rendering of Descartes' notion of 'perfection.' It is the notion of that power in history which implants into the form of process, belonging to each historic epoch, the character of a drive towards some ideal, to be realized within that period. This ideal is never realized, it is beyond realization, and yet it moulds the form of what is realized.

For example, there is an ideal of human liberty, activity, and coöperation dimly adumbrated in the American Constitution. It has never been realized in its perfection; and by its lack of characterization of the variety of possibilities open for humanity, it is limited

and imperfect. And yet, such as it is, the Constitution vaguely discloses the immanence in this epoch of that one energy of idealization, whereby bare process is transformed into glowing history.

In this discussion we are upholding the thesis that the sense of external reality—that is to say, the sense of being one actuality in a world of actualities—is the gift of aesthetic significance. This experience claims a relevance beyond the finite immediacy of any one occasion of experience. If in that occasion, there is a failure consciously to discern that significance, so much the worse for that occasion. This doctrine applies to all experience, great and small. Our intuitions of righteousness disclose an absoluteness in the nature of things, and so does the taste of a lump of sugar.

The variations of importance are beyond our weak imaginations; and yet aesthetic importance in any factor of experience carries its proof of existence beyond present immediacy. The ego enjoys an importance stretching beyond itself.

The rise of animal, and then of human, consciousness is the triumph of specialization. It is closely connected with the evolution of clear and distinct sensory experience. There is abstraction from the vague mass of primary feelings, and concentration upon the comparative clarity of a few qualitative details. These are the sensa.

Unless the physical and physiological sciences are fables, the qualitative experiences which are the sensations, such as sight, hearing, etc., are involved in an intricate flux of reactions within and without the animal body. These are all hidden below consciousness in the vague sense of personal experience of an external world. This feeling is massive and vague—so vague that the pretentious phrase, namely, personal experience of an external world, sounds nonsense. A particular instance can be explained more simply. For example, 'I see a blue stain out there,' implies the privacy of the ego and the externality of 'out there.' There is the presupposition of 'me,' and the world beyond. But consciousness is concentrated on the quality blue in that position. Nothing can be more simple or more abstract. And yet unless the physicist and physiologist are talking nonsense, there is a terrific tale of complex activity omitted in the abstraction.

Further, our subsequent actions conform to the tales of the scientists, and not primarily to the blueness of the stain. We may want to preserve or modify the experience. But inexorably our actions are directive of our bodies. We do not touch the quality blue. We stretch

out our arms to modify the relations of the blue thing to the various activities in its environment.

In so far as we are merely conscious of the formal relationships of qualities, there is aesthetic failure. It is the recognition of the arid fact of the possibility of relationship. The sense of reality is the sense of effectiveness, and the sense of effectiveness is the drive towards the satisfaction of appetition. There is a past, real in its own right, satisfying itself in the present.

10. Fact includes in its own nature something which is not fact, although it constitutes a realized item within fact. This is the conceptual side of fact. But, as usual, the philosophic tradition is too abstract. There is no such independent item in actuality as 'mere concept.' The concept is always clothed with emotion, that is to say, with hope, or with fear, or with hatred, or with eager aspiration, or with the pleasure of analysis. The variations in the quality of appetition are infinite. But the notion of 'mere concept,' or of 'mere realization,' apart from a relevant emotional derivation, which is its emotional origin, is fallacious. The doctrine here maintained is to be found in Hume, except that he oversimplifies the problem by conceiving an initial bare occurrence of sense-impressions devoid of essential relationship to other factors in experience. In his subsequent argument he is apt fortunately to forget his explicit premises. So it is possible to construe his meaning in many ways. But in his controversy with antagonistic modes of thought, he judges them by the strict consequences of these premises.

The final conclusion from the discussions included in this course of lectures is the importance of a right adjustment of the process of abstraction. Those characteristics of experience which separate the higher from the lower species of actualities all depend upon abstraction. The living germs are distinguished from lifeless physical activities by the abstractions inherent in their existence. The higher animals are distinguished from mere life, by their abstractions, and by their use of them. Mankind is distinguished from animal life by its emphasis on abstractions. The degeneracy of mankind is distinguished from its uprise by the dominance of chill abstractions, divorced from aesthetic content.

The growth of consciousness is the uprise of abstractions. It is the growth of emphasis. The totality is characterized by a selection from

its details. That selection claims attention, enjoyment, action, and purpose, all relative to itself. This concentration evokes an energy of self-realization. It is a step towards unification with that drive towards realization which discloses the unity of aim in the historic process.

But this enhancement of energy presupposes that the abstraction is preserved with its adequate relevance to the concrete sense of value-attainment from which it is derived. In this way, the effect of the abstraction stimulates the vividness and depth of the whole of experience. It stirs the depths.

Thus a fortunate use of abstractions is of the essence of upward evolution. But there is no necessity for such good use. Abstractions may function in experience so as to separate them from their relevance to the totality. In that case, the abstractive experience is a flicker of interest which is destroying its own massive basis for survival.

It is interesting to note that in the entertainment of abstractions there is always present a preservative instinct aiming at the renewal of connection, which is the reverse of abstraction. This reverse process, partly instinctive and partly conscious, is wisdom of that higher life made possible by abstraction.

For example, in the consciousness of sense-experience, we first fix attention on some sensory detail. We then glance around and attend to the environment of sights and sounds. We endeavour to lift into consciousness meaningful units, such as the whole picture, the whole building, the living animal, the stone, the mountain, the tree. Such vivid conscious experience is a return to the concrete. The return may be misconceived. The abstraction may misdirect us as to the real complex from which it originates. But, in the dim recesses behind consciousness there is the sense of realities behind abstractions. The sense of process is always present. There is the process of abstraction arising from the concrete totality of value-experience, and this process points back to its origin.

11. But consciousness, which is the supreme vividness of experience, does not rest content with the dumb sense of importance behind the veil. Its next procedure is to seek the essential connections within its own conscious area. This is the process of rationalization. This process is the recognition of essential connection within the ap-

parent isolation of abstracted details. Thus rationalization is the reverse of abstraction, so far as abstraction can be reversed within the area of consciousness.

Our powers are finite. So, although no item in this process of reversion is necessarily beyond us, it is confined within the environment accidentally presented to us by our immediate area of consciousness. Thus rationalization is the partial fulfillment of the ideal to recover concrete reality within the disjunction of abstraction.

This disjunction is the appearance which has been introduced as price of finite conscious discrimination. The concrete reality is the starting-point of the process of individual experience, and it is the goal in the rationalization of consciousness. The prize at the goal is the enhancement of experience by consciousness and rationality.

III. Nature and Life

LECTURE SEVEN *NATURE LIFELESS*

Philosophy is the product of wonder. The effort after the general characterization of the world around us is the romance of human thought. The correct statement seems so easy, so obvious, and yet it is always eluding us. We inherit the traditional doctrine: we can detect the oversights, the superstitions, the rash generalizations of the past ages. We know so well what we mean and yet we remain so curiously uncertain about the formulation of any detail of our knowledge. This word 'detail' lies at the heart of the whole difficulty. You cannot talk vaguely about Nature in general. We must fix upon details within nature and discuss their essences and their types of inter-connection. The world around is complex, composed of details. We have to settle upon the primary types of detail in terms of which we endeavour to express our understanding of Nature. We have to analyse and to abstract, and to understand the natural status of our abstractions. At first sight there are sharp-cut classes within which we can sort the various types of things and characters of things which we find in Nature. Every age manages to find modes of classification which seem fundamental starting points for the researches of the special

sciences. Each succeeding age discovers that the primary classifications of its predecessors will not work. In this way a doubt is thrown upon all formulations of Laws of Nature which assume these classifications as firm starting points. A problem arises. Philosophy is the search for the solution.

Our first step must be to define the term 'nature' as here used. 'Nature,' in these chapters, means the world as interpreted by reliance on clear and distinct sensory experiences, visual, auditory, and tactile. Obviously, such an interpretation is of the highest importance for human understanding. These final chapters are concerned with the question,—How far does it take us?

For example, we can conceive nature as composed of permanent things, namely bits of matter, moving about in space which otherwise is empty. This way of thinking about nature has an obvious consonance with common-sense observation. There are chairs, tables, bits of rock, oceans, animal bodies, vegetable bodies, planets, and suns. The enduring self-identity of a house, of a farm, of an animal body, is a presupposition of social intercourse. It is assumed in legal theory. It lies at the base of all literature. A bit of matter is thus conceived as a passive fact, an individual reality which is the same at an instant, or throughout a second, an hour, or a year. Such a material, individual reality supports its various qualifications such as shape, locomotion, colour, or smell, etc. The occurrences of nature consist in the changes in these qualifications, and more particularly in the changes of motion. The connection between such bits of matter consists purely of spatial relations. Thus the importance of motion arises from its change of the sole mode of interconnection of material things. Mankind then proceeds to discuss these spatial relations and discovers Geometry. The geometrical character of space is conceived as the one way in which Nature imposes determinate relations upon all bits of matter which are the sole occupants of space. In itself, Space is conceived as unchanging from Eternity to Eternity, and as homogeneous from infinity to infinity. Thus we compose a straightforward characterization of Nature, which is consonant to common sense, and can be verified at each moment of our existence. We sit for hours in the same chair, in the same house, with the same animal body. The dimensions of the room are defined by its spatial relations. There are colours, sounds, scents, partly abiding and partly changing. Also the major facts of change are defined by locomotion of the animal bodies

and of the inorganic furniture. Within this general concept of Nature, there have somehow to be interwoven the further concepts of Life and Mind.

I have been endeavouring to sketch the general common-sense notion of the Universe, which about the beginning of the sixteenth century, say in the year 1500 A.D., was in process of formation among the more progressive thinkers of the European population. It was partly an inheritance from Greek thought and from mediaeval thought. Partly it was based on the deliverance of direct observation, at any moment verified in the world around us. It was the presupposed support supplying the terms in which the answers to all further questions were found. Among these further questions, the most fundamental and the most obvious are those concerning the laws of locomotion, the meaning of life, the meaning of mentality, and the interrelations of matter, life, and mentality. When we examine the procedures of the great men in the sixteenth and seventeenth centuries, we find them presupposing this general common-sense notion of the Universe, and endeavouring to answer all questions in the terms it supplies.

I suggest that there can be no doubt but that this general notion expresses large, all-pervading truths about the world around us. The only question is as to how fundamental these truths may be. In other words, we have to ask what large features of the Universe cannot be expressed in these terms. We have also to ask whether we cannot find some other set of notions which will explain the importance of this common-sense notion, and will also explain its relations to those other features ignored by the common-sense notion.

When we survey the subsequent course of scientific thought throughout the seventeenth century up to the present day, two curious facts emerge. In the first place, the development of natural science has gradually discarded every single feature of the original common-sense notion. Nothing whatever remains of it, considered as expressing the primary features in terms of which the Universe is to be interpreted. The obvious common-sense notion has been entirely destroyed, so far as concerns its function as the basis for all interpretation. One by one, every item has been de-throned.

There is a second characteristic of subsequent thought which is equally prominent. This common-sense notion still reigns supreme in the work-a-day life of mankind. It dominates the market-place, the

playgrounds, the Law Courts, and in fact the whole sociological intercourse of mankind. It is supreme in literature and is assumed in all the humanistic sciences. Thus the science of nature stands opposed to the presuppositions of humanism. Where some conciliation is attempted, it often assumes some sort of mysticism. But in general there is no conciliation.

Indeed, even when we confine attention to natural science, no special science ever is grounded upon the conciliation of presuppositions belonging to all the various sciences of nature. Each science confines itself to a fragment of the evidence and weaves its theories in terms of notions suggested by that fragment. Such a procedure is necessary by reason of the limitations of human ability. But its dangers should always be kept in mind. For example, the increasing departmentalization of universities during the last hundred years, however necessary for administrative purposes, tends to trivialize the mentality of the teaching profession. The result of this effective survival of two ways of thought is a patchwork procedure.

Presuppositions from the two points of view are interwoven sporadically. Every special science has to assume results from other sciences. For example, biology presupposes physics. It will usually be the case that these loans from one specialism to another really belong to the state of science thirty or forty years earlier. The presuppositions of the physics of my boyhood are today powerful influences in the mentality of physiologists. Indeed we do not need even to bring in the physiologists. The presuppositions of yesterday's physics remain in the minds of physicists, although their explicit doctrines taken in detail deny them.

In order to understand this sporadic interweaving of old and new in modern thought, I will recur to the main principles of the old common-sense doctrine, which even today is the common doctrine of ordinary life because in some sense it is true. There are bits of matter, enduring self-identically in space which is otherwise empty. Each bit of matter occupies a definite limited region. Each such particle of matter has its own private qualifications, such as its shape, its motion, its mass, its colour, its scent. Some of these qualifications change, others are persistent. The essential relationship between bits of matter is purely spatial. Space itself is eternally unchanging, always including in itself this capacity for the relationship of bits of matter. Geometry is the science which investigates this spatial capacity for imposing

relationship upon matter. Locomotion of matter involves change in spatial relationship. It involves nothing more than that. Matter involves nothing more than spatiality, and the passive support of qualifications. It can be qualified, and it must be qualified. But qualification is a bare fact, which is just itself. This is the grand doctrine of Nature as a self-sufficient, meaningless complex of facts. It is the doctrine of the autonomy of physical science. It is the doctrine which in these lectures I am denying.

The state of modern thought is that every single item in this general doctrine is denied, but that the general conclusions from the doctrine as a whole are tenaciously retained. The result is a complete muddle in scientific thought, in philosophic cosmology, and in epistemology. But any doctrine which does not implicitly presuppose this point of view is assailed as unintelligible.

The first item to be abandoned was the set of qualifications which we distinguish in sense-perception, namely colour, sound, scent, and analogous qualifications. The transmission theories for light and sound introduced the doctrine of secondary qualities. The colour and the sound were no longer in nature. They are the mental reactions of the percipient to internal bodily locomotions. Thus nature is left with bits of matter, qualified by mass, spatial relations, and the change of such relations.

This loss of the secondary qualities was a severe restriction to Nature. For its value to the percipient was reduced to its function as a mere agent of excitement. Also the derived mental excitement was not primarily concerned with factors in nature. The colours and the sounds were secondary factors supplied by the mental reaction. But the curious fact remained that these secondary factors are perceived as related by the spatiality which is the grand substratum of nature. Hume was, I think, the first philosopher who explicitly pointed out this curious hybrid character of our perceptions, according to the current doctrine of the perception of secondary qualities. Though of course this hybrid characteristic was tacitly presupposed by Locke when he conceived colour as a *secondary* quality of the things in Nature. I believe that any cosmological doctrine which is faithful to the facts has to admit this artificial character of sense-perception. Namely, when we perceive the red rose we are associating our enjoyment of red derived from one source with our enjoyment of a spatial region derived from another source. The conclusion that I draw is

that sense-perception for all its practical importance is very superficial in its disclosure of the nature of things. This conclusion is supported by the character of delusiveness—that is, of illusion—which persistently clings to sense-perception. For example, our perception of stars which years ago may have vanished, our perceptions of images in mirrors or by refraction, our double vision, our visions under the influence of drugs. My quarrel with modern Epistemology concerns its exclusive stress upon sense-perception for the provision of data respecting Nature. Sense-perception does not provide the data in terms of which we interpret it.

This conclusion that pure sense-perception does not provide the data for its own interpretation was the great discovery embodied in Hume's philosophy. This discovery is the reason why Hume's *Treatise* will remain as the irrefutable basis for all subsequent philosophic thought.

Another item in the common-sense doctrine concerns empty space and locomotion. In the first place, the transmission of light and sound shows that space apparently empty is the theatre of activities which we do not directly perceive. This conclusion was explained by the supposition of types of subtle matter, namely the ether, which we cannot directly perceive. In the second place, this conclusion, and the obvious behaviour of gross ordinary matter, show us that the motions of matter are in some way conditioned by the spatial relations of material bodies to each other. It was here that Newton supplied the great synthesis upon which science was based for more than two centuries. Newton's laws of motion provided a skeleton framework within which more particular laws for the inter-connection of bodily motions could be inserted. He also supplied one example of such a particular law in his great law of gravitation, which depended upon mutual distances.

Newton's methodology for physics was an overwhelming success. But the forces which he introduced left Nature still without meaning or value. In the essence of a material body—in its mass, motion, and shape—there was no reason for the law of gravitation. Even if the particular forces could be conceived as the accidents of a cosmic epoch, there was no reason in the Newtonian concepts of mass and motion why material bodies should be connected by any stress between them. Yet the notion of stresses, as essential connections between bodies, was a fundamental factor in the Newtonian concept

of nature. What Newton left for empirical investigation was the determination of the particular stresses now existing. In this determination he made a magnificent beginning by isolating the stresses indicated by his law of gravitation. But he left no hint, why in the nature of things there should be any stresses at all. The arbitrary motions of the bodies were thus explained by the arbitrary stresses between material bodies, conjoined with their spatiality, their mass, and their initial states of motion. By introducing stresses—in particular the law of gravitation—instead of the welter of detailed transformations of motion, he greatly increased the systematic aspect of nature. But he left all the factors of the system—more particularly, mass and stress—in the position of detached facts devoid of any reason for their compresence. He thus illustrated a great philosophic truth, that a dead nature can give no reasons. All ultimate reasons are in terms of aim at value. A dead nature aims at nothing. It is the essence of life that it exists for its own sake, as the intrinsic reaping of value.

Thus for Newtonians, Nature yielded no reasons: it could yield no reasons. Combining Newton and Hume we obtain a barren concept, namely a field of perception devoid of any data for its own interpretation, and a system of interpretation, devoid of any reason for the concurrence of its factors. It is this situation that modern philosophy from Kant onwards has in its various ways sought to render intelligible. My own belief is that this situation is a *reductio ad absurdum,* and should not be accepted as the basis for philosophic speculation. Kant was the first philosopher who in this way combined Newton and Hume. He accepted them both, and his three Critiques were his endeavour to render intelligible this Hume-Newton situation. But the Hume-Newton situation is the primary presupposition for all modern philosophic thought. Any endeavour to go behind it is, in philosophic discussions, almost angrily rejected as unintelligible.

My aim in these lectures is briefly to point out how both Newton's contribution and Hume's contribution are, each in their way, gravely defective. They are right as far as they go. But they omit those aspects of the Universe as experienced, and of our modes of experiencing, which jointly lead to the more penetrating ways of understanding. In the recent situations at Washington, D.C., the Hume-Newton modes of thought can only discern a complex transition of sensa, and an entangled locomotion of molecules, while the deepest intuition of the whole world discerns the President of the United States inaugu-

rating a new chapter in the history of mankind. In such ways the Hume-Newton interpretation omits our intuitive modes of understanding.

I now pass on to the influence of modern science in discrediting the remaining items of the primary common-sense notion with which science in the sixteenth century started its career. But in the present-day reconstruction of physics fragments of the Newtonian concepts are stubbornly retained. The result is to reduce modern physics to a sort of mystic chant over an unintelligible Universe. This chant has the exact merits of the old magic ceremonies which flourished in ancient Mesopotamia and later in Europe. One of the earliest fragments of writing which has survived is a report from a Babylonian astrologer to the King, stating the favourable days to turn cattle into the fields, as deduced by his observations of the stars. This mystic relation of observation, theory, and practice, is exactly the present position of science in modern life, according to the prevalent scientific philosophy.

The notion of empty space, the mere vehicle of spatial interconnections, has been eliminated from recent science. The whole spatial universe is a field of force, or in other words, a field of incessant activity. The mathematical formulae of physics express the mathematical relations realized in this activity.

The unexpected result has been the elimination of bits of matter, as the self-identical supports for physical properties. At first, throughout the nineteenth century, the notion of matter was extended. The empty space was conceived as filled with ether. This ether was nothing else than the ordinary matter of the original common-sense notion. It had the properties of a jelly, with its continuity, its cohesion, its flexibility, and its inertia. The ordinary matter of common sense then merely represented certain exceptional entanglements in the ether—that is to say, knots in the ether. These entanglements, which are relatively infrequent throughout space, impose stresses and strains throughout the whole of the jelly-like ether. Also the agitations of ordinary matter are transmitted through the ether as agitations of the stresses and strains. In this way an immense unification was effected of the various doctrines of light, heat, electricity, and energy, which now coalesced into the one science of the ether. The theory was gradually elaborated throughout the nineteenth century by a brilliant group of physicists and mathematicians, French,

German, Dutch, Scandinavian, British, Italian, American. The details of their work, and the relative contributions of various individuals are not to the point here.

The final result is that the activities of the ether are very different from any of the modes of activity which the common-sense analysis ascribes to ordinary matter. If the doctrine of ether be correct, then our ordinary notions of matter are derived from observations of certain average results which cloak the real nature of the activities of ether. The more recent revolution which has culminated in the physics of the present day has only carried one step further this trend of nineteenth century science. Its moral is the extreme superficiality of the broad generalizations which mankind acquires on the basis of sense-perception. The continuous effort to understand the world has carried us far away from all those obvious ideas. Matter has been identified with energy, and energy is sheer activity; the passive substratum composed of self-identical enduring bits of matter has been abandoned, so far as concerns any fundamental description. Obviously this notion expresses an important derivative fact. But it has ceased to be the presupposed basis of theory. The modern point of view is expressed in terms of energy, activity, and the vibratory differentiations of space-time. Any local agitation shakes the whole universe. The distant effects are minute, but they are there. The concept of matter presupposed simple location. Each bit of matter was self-contained, localized in a region with a passive, static network of spatial relations, entwined in a uniform relational system from infinity to infinity and from eternity to eternity. But in the modern concept the group of agitations which we term matter is fused into its environment. There is no possibility of a detached, self-contained local existence. The environment enters into the nature of each thing. Some elements in the nature of a complete set of agitations may remain stable as those agitations are propelled through a changing environment. But such stability is only the case in a general, average way. This average fact is the reason why we find the same chair, the same rock, and the same planet, enduring for days, or for centuries, or for millions of years. In this average fact the time-factor takes the aspect of endurance, and change is a detail. The fundamental fact, according to the physics of the present day, is that the environment with its peculiarities seeps into the group-agitation which we term matter, and the group-

agitations extend their character to the environment. In truth, the notion of the self-contained particle of matter, self-sufficient with its local habitation, is an abstraction. Now an abstraction is nothing else than the omission of part of the truth. The abstraction is well-founded when the conclusions drawn from it are not vitiated by the omitted truth.

This general deduction from the modern doctrine of physics vitiates many conclusions drawn from the applications of physics to other sciences, such as physiology, or even such as physics itself. For example, when geneticists conceive genes as the determinants of heredity. The analogy of the old concept of matter sometimes leads them to ignore the influence of the particular animal body in which they are functioning. They presuppose that a pellet of matter remains in all respects self-identical whatever be its changes of environment. So far as modern physics is concerned, any characteristics may, or may not, effect changes in the genes, changes which are as important in certain respects, though not in others. Thus no *a priori* argument as to the inheritance of characters can be drawn from the mere doctrine of genes. In fact recently physiologists have found that genes are modified in some respects by their environment. The presuppositions of the old common-sense view survive, even when the view itself has been abandoned as a fundamental description.

This survival of fragments of older doctrines is also exemplified in the modern use of the term space-time. The notion of space with its geometry is strictly coördinated to the notion of material bodies with simple location in space. A bit of matter is then conceived as self-sufficient with the simple location of the region which it occupies. It is just there, in that region where it is; and it can be described without reference to the goings-on in any other region of space. The empty space is the substratum for the passive geometrical relationships between material bodies. These relationships are bare, static facts and carry no consequences which are essentially necessary. For example, Newton's law of gravitation expresses the changes of locomotion which are associated with the spatial relations of material bodies with each other. But this law of gravitation does not result from the Newtonian notion of mass combined with the notion of the occupancy of space, together with the Euclidean geometry. None of these notions either singly or in combination give the slightest warrant for the Law of Gravitation. Neither Archimedes, nor Galileo, by puzzling

over these notions could have derived any suggestion for the gravitational law. According to the doctrine, space was the substratum for the great all-pervading passive relationship of the natural world. It conditioned all the active relationships, but it did not necessitate them.

The new view is entirely different. The fundamental concepts are activity and process. Nature is divisible and thus extensive. But any division, including some activities and excluding others, also severs the patterns of process which extend beyond all boundaries. The mathematical formulae indicate a logical completeness about such patterns, a completeness which boundaries destroy. For example, half a wave tells only half the story. The notion of self-sufficient isolation is not exemplified in modern physics. There are no essentially self-contained activities within limited regions. These passive geometrical relationships between substrata passively occupying regions have passed out of the picture. Nature is a theatre for the inter-relations of activities. All things change, the activities and their inter-relations. To this new concept, the notion of space with its passive, systematic, geometric relationship is entirely inappropriate. The fashionable notion that the new physics has reduced all physical laws to the statement of geometrical relations is quite ridiculous. It has done the opposite. In the place of the Aristotelian notion of the procession of forms, it has substituted the notion of the forms of process. It has thus swept away space and matter, and has substituted the study of the internal relations within a complex state of activity. This complex state is in one sense a unity. There is the whole universe of physical action extending to the remotest star-cluster. In another sense it is divisible into parts. We can trace inter-relations within a selected group of activities, and ignore all other activities. By such an abstraction, we shall fail to explain those internal activities which are affected by changes in the external system which has been ignored. Also, in any fundamental sense, we shall fail to understand the retained activities. For these activities will depend upon a comparatively unchanging systematic environment.

In all discussions of nature we must remember the differences of scale, and in particular the differences of time-span. We are apt to take modes of observable functioning of the human body as setting an absolute scale. It is extremely rash to extend conclusions derived from observation far beyond the scale of magnitude to which observa-

tion was confined. For example, to exhibit apparent absence of change within a second of time tells nothing as to the change within a thousand years. Also no apparent change within a thousand years tells anything as to a million years; and no apparent change within a million years tells anything about a million million years. We can extend this progression indefinitely. There is no absolute standard of magnitude. Any term in this progression is large compared to its predecessor and is small compared to its successor.

Again, all special sciences presuppose certain fundamental types of things. Here I am using the word 'thing' in its most general sense, which can include activities, colours and other sensa, and values. In this sense, 'thing' is whatever we can talk about. A science is concerned with a limited set of various types of things. There is thus in the first place this variety of types. In the second place, there is the determination as to what types are exhibited in any indicated situation. For example, there is the singular proposition,—this is green; and the more general proposition,—all those things are green. This type of enquiry is what the traditional Aristotelian Logic takes care of. Undoubtedly such enquiries are essential in the initial stage of any science. But every science strives to get beyond it. Unfortunately, owing to the way in which for over two thousand years philosophic thought has been dominated by its background of Aristotelian Logic, all attempts to combine the set of special sciences into a philosophic cosmology, giving some understanding of the Universe—all these attempts are vitiated by an unconscious relapse into these Aristotelian forms as the sole mode of expression. The disease of philosophy is its itch to express itself in the forms, 'Some S is P,' or 'All S is P.'

Returning to the special sciences, the third step is the endeavour to obtain quantitative decisions. In this stage, the typical questions are, 'How much P is involved in S' and 'How many S's are P?' In other words, number, quantity, and measurement, have been introduced. A simple-minded handling of these quantitative notions can be just as misleading as undue trust in the Aristotelian forms for propositions.

The fourth stage in the development of the science is the introduction of the notion of pattern. Apart from attention to this concept of pattern, our understanding of Nature is crude in the extreme. For example, given an aggregate of carbon atoms and oxygen atoms, and given that the number of oxygen atoms and the number of carbon

atoms are known, the properties of the mixture are unknown until the question of pattern is settled. How much free oxygen is there,—How much free carbon,—How much carbon monoxide,—How much carbon dioxide? The answers to some of these questions, with the total quantities of oxygen and of carbon presupposed, will determine the answer to the rest. But even allowing for this mutual determination, there will be an enormous number of alternative patterns for a mixture of any reasonable amount of carbon and oxygen. And even when the purely chemical pattern is settled, and when the region containing the mixture is given, there are an indefinite number of regional patterns for the distribution of the chemical substances within the containing region. Thus beyond all questions of quantity, there lie questions of pattern, which are essential for the understanding of nature. Apart from a presupposed pattern, quantity determines nothing. Indeed quantity itself is nothing other than analogy of functions within analogous patterns.

Also this example, involving mere chemical mixture, and chemical combination, and the seclusion of different substances in different subregions of the container, shows us that notion of pattern involves the concept of different modes of togetherness. This is obviously a fundamental concept which we ought to have thought of as soon as we started with the notion of various types of fundamental things. The danger of all these fundamental notions is that we are apt to assume them unconsciously. When we ask ourselves any question we will usually find that we are assuming certain types of entities involved, that we are assuming certain modes of togetherness of these entities, and that we are even assuming certain widely spread generalities of pattern. Our attention is concerned with details of pattern, and measurement, and proportionate magnitude. Thus the laws of nature are merely all-pervading patterns of behaviour, of which the shift and discontinuance lie beyond our ken. Again, the topic of every science is an abstraction from the full concrete happenings of nature. But every abstraction neglects the influx of the factors omitted into the factors retained. Thus a single pattern discerned by vision limited to the abstractions within a special science differentiates itself into a subordinate factor in an indefinite number of wider patterns when we consider its possibilities of relatedness to the omitted universe. Even within the circle of the special science we may find diversities of functioning not to be explained in terms of that

science. But these diversities can be explained when we consider the variety of wider relationships of the pattern in question.

Today the attitude among many leaders in natural science is a vehement denial of the considerations which have here been put forward. Their attitude seems to me to be a touching example of baseless faith. This judgment is strengthened when we reflect that their position on the autonomy of the natural sciences has its origin in a concept of the world of nature, now discarded.

Finally, we are left with a fundamental question as yet undiscussed. What are those primary types of things in terms of which the process of the Universe is to be understood? Suppose we agree that Nature discloses to the scientific scrutiny merely activities and process. What does this mean? These activities fade into each other. They arise and then pass away. What is being enacted? What is effected? It cannot be that these are merely the formulae of the multiplication table—in the words of a great philosopher, merely a bloodless dance of categories. Nature is full-blooded. Real facts are happening. Physical Nature, as studied in Science, is to be looked upon as a complex of the more stable inter-relations between the real facts of the real universe.

This lecture has been confined to Nature under an abstraction in which all reference to life was suppressed. The effect of this abstraction has been that Dynamics, Physics, and Chemistry were the sciences which guided our gradual transition from the full common-sense notions of the sixteenth century to the concept of nature suggested by the speculative physics of the present day.

This change of view, occupying four centuries, may be characterized as the transition from Space and Matter as the fundamental notions to Process conceived as a complex of activity with internal relations between its various factors. The older point of view enables us to abstract from change and to conceive of the full reality of nature *at an instant,* in abstraction from any temporal duration and characterized as to its inter-relations solely by the instantaneous distribution of matter in space. According to the Newtonian view, what had thus been omitted was the change of distribution at neighbouring instants. But such change was, on this view, plainly irrelevant to the essential reality of the material universe at the instant considered. Locomotion, and change of relative distribution, were accidental and not essential.

Equally accidental was endurance. Nature at an instant is, in this view, equally real whether or no there be no nature at any other instant, or indeed whether or no there be any other instant. Descartes, who with Galileo and Newton, coöperated in the construction of the final Newtonian view, accepted this conclusion. For he explained endurance as perpetual re-creation at each instant. Thus the matter of fact was, for him, to be seen in the instant and not in the endurance. For him, endurance was a mere succession of instantaneous facts. There were other sides to Descartes' cosmology which might have led him to a greater emphasis on motion. For example, his doctrines of extension and vortices. But in fact, by anticipation, he drew the conclusion which fitted the Newtonian concepts.

There is a fatal contradiction inherent in the Newtonian cosmology. Only one mode of the occupancy of space is allowed for—namely, this bit of matter occupying this region at this durationless instant. This occupation of space is the final real fact, without reference to any other instant, or to any other piece of matter, or to any other region of space. Now assuming this Newtonian doctrine, we ask—What becomes of velocity, at an instant? Again we ask—What becomes of momentum at an instant? These notions are essential for Newtonian physics, and yet they are without any meaning for it. Velocity and momentum require the concept that the state of things at other times and other places enters into the essential character of the material occupancy of space at any selected instant. But the Newtonian concept allows for no such modification of the relation of occupancy. Thus the cosmological scheme is inherently inconsistent. The mathematical subleties of the differential calculus afford no help for the removal of this difficulty. We can indeed phrase the point at issue in mathematical terms. The Newtonian notion of occupancy corresponds to the value of a function at a selected point. But the Newtonian physics requires solely the limit of the function at that point. And the Newtonian cosmology gives no hint why the bare fact which is the value should be replaced by the reference to other times and places which is the limit.

For the modern view process, activity, and change are the matter of fact. At an instant there is nothing. Each instant is only a way of grouping matters of fact. Thus since there are no instants, conceived as simple primary entities, there is no nature at an instant. Thus all

the inter-relations of matters of fact must involve transition in their essence. All realization involves implication in the creative advance.

The discussion in this lecture is only the prolegomenon for the attempt to answer the fundamental question,—How do we add content to the notion of bare activity? Activity for what, producing what, Activity involving what?

The next lecture will introduce the concept of Life, and will thus enable us to conceive of Nature more concretely, without abstraction.

LECTURE EIGHT *NATURE ALIVE*

The status of life in nature, as defined in the previous chapter, is the modern problem of philosophy and of science. Indeed it is the central meeting point of all the strains of systematic thought, humanistic, naturalistic, philosophic. The very meaning of life is in doubt. When we understand it, we shall also understand its status in the world. But its essence and its status are alike baffling.

After all, this conclusion is not very different from our conclusion respecting nature, considered in abstraction from the notion of life. We were left with the notion of an activity in which nothing is effected. Also this activity, thus considered, discloses no ground for its own coherence. There is merely a formula for succession. But there is an absence of understandable causation to give a reason for that formula for that succession. Of course it is always possible to work oneself into a state of complete contentment with an ultimate irrationality. The popular positivistic philosophy adopts this attitude.

The weakness of this positivism is the way in which we all welcome the detached fragments of explanation attained in our present stage of civilization. Suppose that a hundred thousand years ago our ancestors had been wise positivists. They sought for no reasons. What they had observed was sheer matter of fact. It was the development of no necessity. They would have searched for no reasons underlying facts immediately observed. Civilization would never have developed. Our varied powers of detailed observation of the world

would have remained dormant. For the peculiarity of a reason is that the intellectual development of its consequences suggests consequences beyond the topics already observed. The extension of observation waits upon some dim apprehension of reasonable connection. For example, the observation of insects on flowers dimly suggests some congruity between the natures of insects and of flowers, and thus leads to a wealth of observation from which whole branches of science have developed. But a consistent positivist should be content with the observed facts, namely insects visiting flowers. It is a fact of charming simplicity. There is nothing further to be said upon the matter, according to the doctrine of a positivist. At present the scientific world is suffering from a bad attack of muddle-headed positivism, which arbitrarily applies its doctrine and arbitrarily escapes from it. The whole doctrine of life in nature has suffered from this positivist taint. We are told that there is the routine described in physical and chemical formulae, and that in the process of nature there is nothing else.

The origin of this persuasion is the dualism which gradually developed in European thought in respect to mind and nature. At the beginning of the modern period Descartes expresses this dualism with the utmost distinctness. For him, there are material substances with spatial relations, and mental substances. The mental substances are external to the material substances. Neither type requires the other type for the completion of its essence. Their unexplained interrelations are unnecessary for their respective existences. In truth, this formulation of the problem in terms of minds and matter is unfortunate. It omits the lower forms of life, such as vegetation and the lower animal types. These forms touch upon human mentality at their highest, and upon inorganic nature at their lowest.

The effect of this sharp division between nature and life has poisoned all subsequent philosophy. Even when the coördinate existence of the two types of actualities is abandoned, there is no proper fusion of the two in most modern schools of thought. For some, nature is mere appearance and mind is the sole reality. For others, physical nature is the sole reality and mind is an epiphenomenon. Here the phrases 'mere appearance' and 'epiphenomenon' obviously carry the implication of slight importance for the understanding of the final nature of things.

The doctrine that I am maintaining is that neither physical nature

nor life can be understood unless we fuse them together as essential factors in the composition of 'really real' things whose inter-connections and individual characters constitute the universe.

The first step in the argument must be to form some concept of what life can mean. Also we require that the deficiencies in our concept of physical nature should be supplied by its fusion with life. And we require that, on the other hand, the notion of life should involve the notion of physical nature.

Now as a first approximation the notion of life implies a certain absoluteness of self-enjoyment. This must mean a certain immediate individuality, which is a complex process of appropriating into a unity of existence the many data presented as relevant by the physical processes of nature. Life implies the absolute, individual self-enjoyment arising out of this process of appropriation. I have, in my recent writings, used the word 'prehension' to express this process of appropriation. Also I have termed each individual act of immediate self-enjoyment an 'occasion of experience.' I hold that these unities of existence, these occasions of experience, are the really real things which in their collective unity compose the evolving universe, ever plunging into the creative advance.

But these are forward references to the issue of the argument. As a first approximation we have conceived life as implying absolute, individual self-enjoyment of a process of appropriation. The data appropriated are provided by the antecedent functioning of the universe. Thus the occasion of experience is absolute in respect to its immediate self-enjoyment. How it deals with its data is to be understood without reference to any other concurrent occasions. Thus the occasion, in reference to its internal process, requires no contemporary process in order to exist. In fact this mutual independence in the internal process of self-adjustment is the definition of contemporaneousness.

This concept of self-enjoyment does not exhaust that aspect of process here termed 'life.' Process for its intelligibility involves the notion of a creative activity belonging to the very essence of each occasion. It is the process of eliciting into actual being factors in the universe which antecedently to that process exist only in the mode of unrealized potentialities. The process of self-creation is the transformation of the potential into the actual, and the fact of such transformation includes the immediacy of self-enjoyment.

Thus in conceiving the function of life in an occasion of experience, we must discriminate the actualized data presented by the antecedent world, the non-actualized potentialities which lie ready to promote their fusion into a new unity of experience, and the immediacy of self-enjoyment which belongs to the creative fusion of those data with those potentialities. This is the doctrine of the creative advance whereby it belongs to the essence of the universe, that it passes into a future. It is nonsense to conceive of nature as a static fact, even for an instant devoid of duration. There is no nature apart from transition, and there is no transition apart from temporal duration. This is the reason why the notion of an instant of time, conceived as a primary simple fact, is nonsense.

But even yet we have not exhausted the notion of creation which is essential to the understanding of nature. We must add yet another character to our description of life. This missing characteristic is 'aim.' By this term 'aim' is meant the exclusion of the boundless wealth of alternative potentiality, and the inclusion of that definite factor of novelty which constitutes the selected way of entertaining those data in that process of unification. The aim is at that complex of feeling which is the enjoyment of those data in that way. 'That way of enjoyment' is selected from the boundless wealth of alternatives. It has been aimed at for actualization in that process.

Thus the characteristics of life are absolute self-enjoyment, creative activity, aim. Here 'aim' evidently involves the entertainment of the purely ideal so as to be directive of the creative process. Also the enjoyment belongs to the process and is not a characteristic of any static result. The aim is at the enjoyment belonging to the process.

The question at once arises as to whether this factor of life in nature, as thus interpreted, corresponds to anything that we observe in nature. All philosophy is an endeavor to obtain a self-consistent understanding of things observed. Thus its development is guided in two ways, one is the demand for a coherent self-consistency, and the other is the elucidation of things observed. It is therefore our first task to compare the above doctrine of life in nature with our direct observations.

Without doubt the sort of observations most prominent in our conscious experience are the sense-perceptions. Sight, hearing, taste, smell, touch, constitute a rough list of our major modes of perception through the senses. But there are an indefinite set of obscure bodily

feelings which form a background of feeling with items occasionally flashing into prominence. The peculiarity of sense-perception is its dual character, partly irrelevant to the body and partly referent to the body. In the case of sight, the irrelevance to the body is at its maximum. We look at the scenery, at a picture, or at an approaching car on the road, as an external presentation given for our mental entertainment or mental anxiety. There it is, exposed to view. But on reflection, we elicit the underlying experience that we were seeing with our eyes. Usually this fact is not in explicit consciousness at the moment of perception. The bodily reference is recessive, the visible presentation is dominant. In the other modes of sensation, the body is more prominent. There is great variation in this respect between the different modes. In any doctrine as to the information derived from sense-perception this dual reference, external reference and bodily reference, should be kept in mind. The current philosophic doctrines, mostly derived from Hume, are defective by reason of their neglect of bodily reference. Their vice is the deduction of a sharp-cut doctrine from an assumed sharp-cut mode of perception. The truth is that our sense-perceptions are extraordinarily vague and confused modes of experience. Also there is every evidence that their prominent side of external reference is very superficial in its disclosure of the universe. It is important. For example, pragmatically a paving-stone is a hard, solid, static, irremoveable fact. This is what sense-perception, on its sharp-cut side, discloses. But if physical science be correct, this is a very superficial account of that portion of the universe which we call the paving-stone. Modern physical science is the issue of a coördinated effort, sustained for more than three centuries, to understand those activities of Nature by reason of which the transitions of sense-perception occur.

Two conclusions are now abundantly clear. One is that sense-perception omits any discrimination of the fundamental activities within nature. For example, consider the difference between the paving-stone as perceived visually, or by falling upon it, and the molecular activities of the paving-stone as described by the physicist. The second conclusion is the failure of science to endow its formulae for activity with any meaning. The divergence of the formulae about nature from the appearance of nature has robbed the formulae of any explanatory character. It has even robbed us of reason for believing that the past gives any ground for expectation of the future.

In fact, science conceived as resting on mere sense-perception, with no other source of observation, is bankrupt, so far as concerns its claim to self-sufficiency.

Science can find no individual enjoyment in nature: Science can find no aim in nature: Science can find no creativity in nature; it finds mere rules of succession. These negations are true of Natural Science. They are inherent in its methodology. The reason for this blindness of Physical Science lies in the fact that such Science only deals with half the evidence provided by human experience. It divides the seamless coat—or, to change the metaphor into a happier form, it examines the coat, which is superficial, and neglects the body which is fundamental.

The disastrous separation of body and mind which has been fixed on European thought by Descartes is responsible for this blindness of Science. In one sense the abstraction has been a happy one, in that it has allowed the simplest things to be considered first, for about ten generations. Now these simplest things are those widespread habits of nature that dominate the whole stretch of the universe within our remotest, vaguest observation. None of these Laws of Nature gives the slightest evidence of necessity. They are the modes of procedure which within the scale of our observations do in fact prevail. I mean, the fact that the extensiveness of the Universe is dimensional, the fact that the number of spatial dimensions is three, the spatial laws of geometry, the ultimate formulae for physical occurrences. There is no necessity in any of these ways of behaviour. They exist as average, regulative conditions because the majority of actualities are swaying each other to modes of interconnection exemplifying those laws. New modes of self-expression may be gaining ground. We cannot tell. But, to judge by all analogy, after a sufficient span of existence our present laws will fade into unimportance. New interests will dominate. In our present sense of the term, our spatio-physical epoch will pass into that background of the past, which conditions all things dimly and without evident effect on the decision of prominent relations.

These massive laws, at present prevailing, are the general physical laws of inorganic nature. At a certain scale of observation they are prevalent without hint of interference. The formation of suns, the motions of planets, the geologic changes on the earth, seem to

proceed with a massive impetus which excludes any hint of modification by other agencies. To this extent sense-perception on which science relies discloses no aim in nature.

Yet it is untrue to state that the general observation of mankind, in which sense-perception is only one factor, discloses no aim. The exact contrary is the case. All explanations of the sociological functionings of mankind include 'aim' as an essential factor in explanation. For example, in a criminal trial where the evidence is circumstantial the demonstration of motive is one chief reliance of the prosecution. In such a trial would the defence plead the doctrine that purpose could not direct the motions of the body, and that to indict the thief for stealing was analogous to indicting the sun for rising? Again no statesman can conduct international relations without some estimate—implicit or explicit in his consciousness—of the types of patriotism respectively prevalent in various nations and in the statesmen of these nations. A lost dog can be seen trying to find his master or trying to find his way home. In fact we are *directly* conscious of our purposes as *directive* of our actions. Apart from such direction no doctrine could in any sense be acted upon. The notions entertained mentally would have no effect upon bodily actions. Thus what happens would happen in complete indifference to the entertainment of such notions.

Scientific reasoning is completely dominated by the presupposition that mental functionings are not properly part of nature. Accordingly it disregards all those mental antecedents which mankind habitually presuppose as effective in guiding cosmological functionings. As a method this procedure is entirely justifiable, provided that we recognize the limitations involved. These limitations are both obvious and undefined. The gradual eliciting of their definition is the hope of philosophy.

The points that I would emphasize are, first that this sharp division between mentality and nature has no ground in our fundamental observation. We find ourselves living within nature. Secondly, I conclude that we should conceive mental operations as among the factors which make up the constitution of nature. Thirdly, that we should reject the notion of idle wheels in the process of nature. Every factor which emerges makes a difference, and that difference can only be expressed in terms of the individual character of that factor.

Fourthly, that we have now the task of defining natural facts, so as to understand how mental occurrences are operative in conditioning the subsequent course of nature.

A rough division can be made of six types of occurrences in nature. The first type is human existence, body and mind. The second type includes all sorts of animal life, insects, the vertebrates, and other genera. In fact all the various types of animal life other than human. The third type includes all vegetable life. The fourth type consists of the single living cells. The fifth type consists of all large scale inorganic aggregates, on a scale comparable to the size of animal bodies, or larger. The sixth type is composed of the happenings on an infinitesimal scale, disclosed by the minute analysis of modern physics.

Now all these functionings of Nature influence each other, require each other, and lead on to each other. The list has purposely been made roughly, without any scientific pretension. The sharp-cut scientific classifications are essential for scientific method. But they are dangerous for philosophy. Such classification hides the truth that the different modes of natural existence shade off into each other. There is the animal life with its central direction of a society of cells, there is the vegetable life with its organized republic of cells, there is the cell life with its organized republic of molecules, there is the large-scale inorganic society of molecules with its passive acceptance of necessities derived from spatial relations, there is the infra-molecular activity which has lost all trace of the passivity of inorganic nature on a larger scale.

In this survey some main conclusions stand out. One conclusion is the diverse modes of functioning which are produced by diverse modes of organization. The second conclusion is the aspect of continuity between these different modes. There are border-line cases, which bridge the gaps. Often the border-line cases are unstable, and pass quickly. But span of existence is merely relative to our habits of human life. For infra-molecular occurrence, a second is a vast period of time. A third conclusion is the difference in the aspects of nature according as we change the scale of observation. Each scale of observation presents us with average effects proper to that scale.

Again, another consideration arises. How do we observe nature? Also, what is the proper analysis of an observation? The conventional answer to this question is that we perceive nature through our senses. Also in the analysis of sense-perception we are apt to concentrate

upon its most clear-cut instance, namely sight. Now visual perception is the final product of evolution. It belongs to high grade animals—to vertebrates and to the more advanced type of insects. There are numberless living things which afford no evidence of possessing sight. Yet they show every sign of taking account of their environment in the way proper to living things. Also human beings shut off sight with peculiar ease, by closing our eyes or by the calamity of blindness. The information provided by mere sight is peculiarly barren—namely external regions disclosed as coloured. There is no necessary transition of colours, and no necessary selection of regions, and no necessary mutual adaptation of the display of colours. Sight at any instant merely provides the passive fact of regions variously coloured. If we have memories, we observe the transition of colours. But there is nothing intrinsic to the mere coloured regions which provides any hint of internal activity whereby change can be understood. It is from this experience that our conception of a spatial distribution of passive material substances arises. Nature is thus described as made up of vacuous bits of matter with no internal values, and merely hurrying through space.

But there are two accompaniments of this experience which should make us suspicious of accepting it at its face value as any direct disclosure of the metaphysical nature of things. In the first place, even in visual experience we are also aware of the intervention of the body. We know directly that we see *with our eyes*. That is a vague feeling, but extremely important. Secondly, every type of crucial experiment proves that what we see, and where we see it, depend entirely upon the physiological functioning of our body. Any method of making our body function internally in a given way, will provide us with an assigned visual sensation. The body is supremely indifferent to the happenings of nature a short way off, where it places its visual sensa.

Now the same is true of all other modes of sensation, only to a greater extent. All sense-perception is merely one outcome of the dependence of our experience upon bodily functionings. Thus if we wish to understand the relation of our personal experience to the activities of nature, the proper procedure is to examine the dependence of our personal experiences upon our personal bodies.

Let us ask about our overwhelming persuasions as to our own personal body-mind relation. In the first place, there is the claim

to unity. The human individual is one fact, body and mind. This claim to unity is the fundamental fact, always presupposed, rarely explicitly formulated. I am experiencing and my body is mine. In the second place, the functioning of our body has a much wider influence than the mere production of sense-experience. We find ourselves in a healthy enjoyment of life by reason of the healthy functionings of our internal organs—heart, lungs, bowels, kidneys, etc. The emotional state arises just because they are not providing any sensa directly associated with themselves. Even in sight, we enjoy our vision because there is no eye-strain. Also we enjoy our general state of life, because we have no stomach-ache. I am insisting that the enjoyment of health, good or bad, is a positive feeling only casually associated with particular sensa. For example, you can enjoy the ease with which your eyes are functioning even when you are looking at a bad picture or a vulgar building. This direct feeling of the derivation of emotion from the body is among our fundamental experiences. There are emotions of various types —but every type of emotion is at least modified by derivation from the body. It is for physiologists to analyse in detail the modes of bodily functioning. For philosophy, the one fundamental fact is that the whole complexity of mental experience is either derived or modified by such functioning. Also our basic feeling is this sense of derivation, which leads to our claim for unity, body and mind.

But our immediate experience also claims derivation from another source, and equally claims a unity founded upon this alternative source of derivation. This second source is our own state of mind directly preceding the immediate present of our conscious experience. A quarter of a second ago, we were entertaining such and such ideas, we were enjoying such and such emotions, and we were making such and such observations of external fact. In our present state of mind, we are continuing that previous state. The word 'continuing' states only half the truth. In one sense it is too weak, and in another sense it overstates. It is too weak, because we not only continue, but we claim absolute identity with our previous state. It was our very identical self in that state of mind, which is of course the basis of our present experience a quarter of a second later. In another sense the word 'continuing' overstates. For we do not quite continue in our preceding state of experience. New elements have intervened. All of

these new elements are provided by our bodily functionings. We fuse these new elements with the basic stuff of experience provided by our state of mind a quarter of a second ago. Also, as we have already agreed, we claim an identification with our body. Thus our experience in the present discloses its own nature as with two sources of derivation, namely, the body and the antecedent experiential functionings. Also there is a claim for identification with each of these sources. The body is mine, and the antecedent experience is mine. Still more, there is only one ego, to claim the body and to claim the stream of experience. I submit that we have here the fundamental basic persuasion on which we found the whole practice of our existence. While we exist, body and soul are inescapable elements in our being, each with the full reality of our own immediate self. But neither body nor soul possesses the sharp observational definition which at first sight we attribute to them. Our knowledge of the body places it as a complex unity of happenings within the larger field of nature. But its demarcation from the rest of nature is vague in the extreme. The body consists of the coördinated functionings of billions of molecules. It belongs to the structural essence of the body that, in an indefinite number of ways, it is always losing molecules and gaining molecules. When we consider the question with microscopic accuracy, there is no definite boundary to determine where the body begins and external nature ends. Again the body can lose whole limbs, and yet we claim identity with the same body. Also the vital functions of the cells in the amputated limb ebb slowly. Indeed the limb survives in separation from the body for an immense time compared to the internal vibratory periods of its molecules. Also apart from such catastrophes, the body requires the environment in order to exist. Thus there is a unity of the body with the environment, as well as a unity of body and soul into one person.

But in conceiving our personal identity we are apt to emphasize rather the soul than the body. The one individual is that coördinated stream of personal experiences, which is my thread of life or your thread of life. It is that succession of self-realization, each occasion with its direct memory of its past and with its anticipation of the future. That claim to enduring self-identity is our self-assertion of personal identity.

Yet when we examine this notion of the soul, it discloses itself

as even vaguer than our definition of the body. First, the continuity of the soul—so far as concerns consciousness—has to leap gaps in time. We sleep or we are stunned. And yet it is the same person who recovers consciousness. We trust to memory, and we ground our trust on the continuity of the functionings of nature, more especially on the continuity of our body. Thus nature in general and the body in particular provide the stuff for the personal endurance of the soul. Again there is a curious variation in the vividness of the successive occasions of the soul's existence. We are living at full stretch with a keen observation of external occurrence; then external attention dies away and we are lost in meditation; the meditation gradually weakens in vivid presentation: we doze; we dream; we sleep with a total lapse of the stream of consciousness. These functionings of the soul are diverse, variable, and discontinuous. The claim to the unity of the soul is analogous to the claim to the unity of the body, and is analogous to the claim to the unity of body and soul, and is analogous to the claim to the community of the body with an external nature. It is the task of philosophic speculation to conceive the happenings of the universe so as to render understandable the outlook of physical science and to combine this outlook with these direct persuasions representing the basic facts upon which epistemology must build. The weakness of the epistemology of the eighteenth and nineteenth centuries was that it based itself purely upon a narrow formulation of sense-perception. Also among the various modes of sensation, visual experience was picked out as the typical example. The result was to exclude all the really fundamental factors constituting our experience.

In such an epistemology we are far from the complex data which philosophic speculation has to account for in a system rendering the whole understandable. Consider the types of community of body and soul, of body and nature, of soul and nature, or successive occasions of bodily existence, or the soul's existence. These fundamental interconnections have one very remarkable characteristic. Let us ask what is the function of the external world for the stream of experience which constitutes the soul. This world, thus experienced, is the basic fact within those experiences. All the emotions, and purposes, and enjoyments, proper to the individual existence of the soul are nothing other than the soul's reactions to this ex-

perienced world which lies at the base of the soul's existence.

Thus in a sense, the experienced world is one complex factor in the composition of many factors constituting the essence of the soul. We can phrase this shortly by saying that in one sense the world is in the soul.

But there is an antithetical doctrine balancing this primary truth. Namely, our experience of the world involves the exhibition of the soul itself as one of the components within the world. Thus there is a dual aspect to the relationship of an occasion of experience as one relatum and the experienced world as another relatum. The world is included within the occasion in one sense, and the occasion is included in the world in another sense. For example, I am in the room, and the room is an item in my present experience. But my present experience is what I now am.

But this baffling antithetical relation extends to all the connections which we have been discussing. For example, consider the enduring self-identity of the soul. The soul is nothing else than the succession of my occasions of experience, extending from birth to the present moment. Now, at this instant, I am the complete person embodying all these occasions. They are mine. On the other hand it is equally true that my immediate occasion of experience, at the present moment, is only one among the stream of occasions which constitutes my soul. Again, the world for me is nothing else than how the functionings of my body present it for my experience. The world is thus wholly to be discerned within those functionings. Knowledge of the world is nothing else than an analysis of the functionings. And yet, on the other hand, the body is merely one society of functionings within the universal society of the world. We have to construe the world in terms of the bodily society, and the bodily society in terms of the general functionings of the world.

Thus, as disclosed in the fundamental essence of our experience, the togetherness of things involves some doctrine of mutual immanence. In some sense or other, this community of the actualities of the world means that each happening is a factor in the nature of every other happening. After all, this is the only way in which we can understand notions habitually employed in daily life. Consider our notion of 'causation'. How can one event be the cause of another? In the first place, no event can be wholly

and solely the cause of another event. The whole antecedent world conspires to produce a new occasion. But some one occasion in an important way conditions the formation of a successor. How can we understand this process of conditioning?

The mere notion of transferring a quality is entirely unintelligible. Suppose that two occurrences may be in fact detached so that one of them is comprehensible without reference to the other. Then all notion of causation between them, or of conditioning, becomes unintelligible. There is—with this supposition—no reason why the possession of any quality by one of them should in any way influence the possession of that quality, or of any other quality, by the other. With such a doctrine the play and interplay of qualitative succession in the world becomes a blank fact from which no conclusions can be drawn as to past, present, or future, beyond the range of direct observation. Such a positivistic belief is quite self-consistent, provided that we do not include in it any hopes for the future or regrets for the past. Science is then without any importance. Also effort is foolish, because it determines nothing. The only intelligible doctrine of causation is founded on the doctrine of immanence. Each occasion presupposes the antecedent world as active in its own nature. This is the reason why events have a determinate status relatively to each other. Also it is the reason why the qualitative energies of the past are combined into a pattern of qualitative energies in each present occasion. This is the doctrine of causation. It is the reason why it belongs to the essence of each occasion that it is *where* it is. It is the reason for the transference of character from occasion to occasion. It is the reason for the relative stability of laws of nature, some laws for a wider environment, some laws for a narrower environment. It is the reason why —as we have already noted—in our direct apprehension of the world around us we find that curious habit of claiming a two-fold unity with the observed data. We are in the world and the world is in us. Our immediate occasion is in the society of occasions forming the soul, and our soul is in our present occasion. The body is ours, and we are an activity within our body. This fact of observation, vague but imperative, is the foundation of the connexity of the world, and of the transmission of its types of order.

In this survey of the observational data in terms of which our philosophical cosmology must be founded, we have brought to-

gether the conclusions of physical science, and those habitual persuasions dominating the sociological functionings of mankind. These persuasions also guide the humanism of literature, of art, and of religion. Mere existence has never entered into the consciousness of man, except as the remote terminus of an abstraction in thought. Descartes' 'Cogito, ergo sum' is wrongly translated, 'I *think,* therefore I am.' It is never bare thought or bare existence that we are aware of. I find myself as essentially a unity of emotions, enjoyments, hopes, fears, regrets, valuations of alternatives, decisions—all of them subjective reactions to the environment as active in my nature. My unity—which is Descartes' 'I am'—is my process of shaping this welter of material into a consistent pattern of feelings. The individual enjoyment is what I am in my role of a natural activity, as I shape the activities of the environment into a new creation, which is myself at this moment; and yet, as being myself, it is a continuation of the antecedent world. If we stress the role of the environment, this process is causation. If we stress the role of my immediate pattern of active enjoyment, this process is self-creation. If we stress the role of the conceptual anticipation of the future whose existence is a necessity in the nature of the present, this process is the teleological aim at some ideal in the future. This aim, however, is not really beyond the present process. For the aim at the future is an enjoyment in the present. It thus effectively conditions the immediate self-creation of the new creature.

We can now again ask the final question as put forward at the close of the former lecture. Physical science has reduced nature to activity, and has discovered abstract mathematical formulae which are illustrated in these activities of Nature. But the fundamental question remains, How do we add content to the notion of bare activity? This question can only be answered by fusing life with nature.

In the first place, we must distinguish life from mentality. Mentality involves conceptual experience, and is only one variable ingredient in life. The sort of functioning here termed 'conceptual experience' is the entertainment of possibilities for ideal realization in abstraction from any sheer physical realization. The most obvious example of conceptual experience is the entertainment of alternatives. Life lies below this grade of mentality. Life is the enjoyment of emotion, derived from the past and aimed at the future. It is the enjoyment

of emotion which was then, which is now, and which will be then. This vector character is of the essence of such entertainment.

The emotion transcends the present in two ways. It issues from, and it issues towards. It is received, it is enjoyed, and it is passed along, from moment to moment. Each occasion is an activity of concern, in the Quaker sense of that term. It is the conjunction of transcendence and immanence. The occasion is concerned, in the way of feeling and aim, with things that in their own essence lie beyond it; although these things in their present functions are factors in the concern of that occasion. Thus each occasion, although engaged in its own immediate self-realization, is concerned with the universe.

The process is always a process of modification by reason of the numberless avenues of supply, and by reason of the numberless modes of qualitative texture. The unity of emotion, which is the unity of the present occasion, is a patterned texture of qualities, always shifting as it is passed into the future. The creative activity aims at preservation of the components and at preservation of intensity. The modifications of pattern, the dismissal into elimination, are in obedience to this aim.

In so far as conceptual mentality does not intervene, the grand patterns pervading the environment are passed on with the inherited modes of adjustment. Here we find the patterns of activity studied by the physicists and chemists. Mentality is merely latent in all these occasions as thus studied. In the case of inorganic nature any sporadic flashes are inoperative so far as our powers of discernment are concerned. The lowest stages of effective mentality, controlled by the inheritance of physical pattern, involve the faint direction of emphasis by unconscious ideal aim. The various examples of the higher forms of life exhibit the variety of grades of effectiveness of mentality. In the social habits of animals, there is evidence of flashes of mentality in the past which have degenerated into physical habits. Finally in the higher mammals and more particularly in mankind, we have clear evidence of mentality habitually effective. In our own experience, our knowledge consciously entertained and systematized can only mean such mentality, directly observed.

The qualities entertained as objects in conceptual activity are of the nature of catalytic agents, in the sense in which that phrase is used in chemistry. They modify the aesthetic process by which the occasion constitutes itself out of the many streams of feeling received from the past. It is not necessary to assume that conceptions

introduce additional sources of measurable energy. They may do so; for the doctrine of the conservation of energy is not based upon exhaustive measurements. But the operation of mentality is primarily to be conceived as a diversion of the flow of energy.

In these lectures I have not entered upon systematic metaphysical cosmology. The object of the lectures is to indicate those elements in our experience in terms of which such a cosmology should be constructed. The key notion from which such construction should start is that the energetic activity considered in physics is the emotional intensity entertained in life.

Philosophy begins in wonder. And, at the end, when philosophic thought has done its best, the wonder remains. There have been added, however, some grasp of the immensity of things, some purification of emotion by understanding. Yet there is a danger in such reflections. An immediate good is apt to be thought of in the degenerate form of a passive enjoyment. Existence is activity ever merging into the future. The aim at philosophic understanding is the aim at piercing the blindness of activity in respect to its transcendent functions.

IV. Epilogue

LECTURE NINE *THE AIM OF PHILOSOPHY*

The task of a University is the creation of the future, so far as rational thought, and civilized modes of appreciation, can affect the issue. The future is big with every possibility of achievement and of tragedy.

Amid this scene of creative action, What is the special function of philosophy?

In order to answer this question, we must first decide what constitutes the philosophic character of any particular doctrine. What makes a doctrine philosophical? No one truth, thoroughly understood in all the infinitude of its bearings, is more or less philosophical than any other truth. The pursuit of philosophy is the one avocation denied to omniscience.

Philosophy is an attitude of mind towards doctrines ignorantly

entertained. By the phrase 'ignorantly entertained' I mean that the full meaning of the doctrine in respect to the infinitude of circumstances to which it is relevant, is not understood. The philosophic attitude is a resolute attempt to enlarge the understanding of the scope of application of every notion which enters into our current thought. The philosophic attempt takes every word, and every phrase, in the verbal expression of thought, and asks, What does it mean? It refuses to be satisfied by the conventional presupposition that every sensible person knows the answer. As soon as you rest satisfied with primitive ideas, and with primitive propositions, you have ceased to be a philosopher.

Of course you have got to start somewhere for the purposes of discourse. But the philosopher, as he argues from his premises, has already marked down every word and phrase in them as topics for future enquiry. No philosopher is satisfied with the concurrence of sensible people, whether they be his colleagues, or even his own previous self. He is always assaulting the boundaries of finitude.

The scientist is also enlarging knowledge. He starts with a group of primitive notions and of primitive relations between these notions, which defines the scope of his science. For example, Newtonian dynamics assumes Euclidean space, massive matter, motion, stresses and strains, and the more general notion of force. There are also the laws of motion, and a few other concepts added later. The science consisted in the deduction of consequences, presupposing the applicability of these ideas.

In respect to Newtonian Dynamics, the scientist and the philosopher face in opposite directions. The scientist asks for the consequences, and seeks to observe the realization of such consequences in the universe. The philosopher asks for the meaning of these ideas in terms of the welter of characterizations which infest the world.

It is evident that scientists and philosophers can help each other. For the scientist sometimes wants a new idea, and the philosopher is enlightened as to meanings by the study of the scientific consequences. Their usual mode of intercommunication is by sharing in the current habits of cultivated thought.

There is an insistent presupposition continually sterilizing philosophic thought. It is the belief, the very natural belief, that mankind has consciously entertained all the fundamental ideas which are applicable to its experience. Further it is held that human language, in

single words or in phrases, explicitly expresses these ideas. I will term this presupposition, The Fallacy of the Perfect Dictionary.

It is here that the philosopher, as such, parts company with the scholar. The scholar investigates human thought and human achievement, armed with a dictionary. He is the main support of civilized thought. Apart from scholarship, you may be moral, religious, and delightful. But you are not wholly civilized. You will lack power of delicate accuracy of expression.

It is obvious that the philosopher needs scholarship, just as he needs science. But both science and scholarship are subsidiary weapons for philosophy.

The Fallacy of the Perfect Dictionary divides philosophers into two schools, namely, the 'Critical School' which repudiates speculative philosophy, and the 'Speculative School' which includes it. The critical school confines itself to verbal analysis within the limits of the dictionary. The speculative school appeals to direct insight, and endeavors to indicate its meanings by further appeal to situations which promote such specific insights. It then enlarges the dictionary. The divergence between the schools is the quarrel between safety and adventure.

The strength of the critical school lies in the fact that the doctrine of evolution never entered, in any radical sense, into ancient scholarship. Thus there arises the presupposition of a fixed specification of the human mind; and the blue print of this specification is the dictionary.

I appeal to two great moments in the history of philosophy. Socrates spent his life in analysing the current presuppositions of the Athenian world. He explicitly recognized that his philosophy was an attitude in the face of ignorance. He was critical and yet constructive.

Harvard is justly proud of the great period of its philosophic department about thirty years ago. Josiah Royce, William James, Santayana, George Herbert Palmer, Münsterberg, constitute a group to be proud of. Among them Palmer's achievements centre chiefly in literature and in his brilliance as a lecturer. The group is a group of men individually great. But as a group they are greater still. It is a group of adventure, of speculation, of search for new ideas. To be a philosopher is to make some humble approach to the main characteristic of this group of men.

The use of philosophy is to maintain an active novelty of funda-

mental ideas illuminating the social system. It reverses the slow descent of accepted thought towards the inactive commonplace. If you like to phrase it so, philosophy is mystical. For mysticism is direct insight into depths as yet unspoken. But the purpose of philosophy is to rationalize mysticism: not by explaining it away, but by the introduction of novel verbal characterizations, rationally coördinated.

Philosophy is akin to poetry, and both of them seek to express that ultimate good sense which we term civilization. In each case there is reference to form beyond the direct meanings of words. Poetry allies itself to metre, philosophy to mathematic pattern.

A Note On Whitehead's Terminology

In the development of his philosophy Whitehead deliberately introduces a new terminology, for the reason that the older terminologies, based on earlier attempts to 'frame a coherent, logical, necessary system of general ideas,' are inadequate to convey his newer scheme. For a basic language of subjects and predicates, substance, attribute, and so on, he substitutes such terms as 'prehension,' 'eternal object,' and 'ingression.'

Since his new terminology affects the most basic concepts of his philosophy, it is clear that attempts to translate his terms into an older philosophical vocabulary are fraught with the dangers of distortion and misinterpretation. Indeed, such an attempt is an invitation to by-pass the essential originality of Whitehead's own thinking.

Whitehead's approach to definitions is that of a formal logician. Each new concept is defined in terms of some previously defined concept, until ultimately there remain those primitive concepts, undefined formally in the system, which are the fundamental defining concepts for the system. If the given system is a subordinate one, included in a larger system, then the basic, undefined ideas of the subordinate system can be explained in the context of the larger system. However, if the system in question is intended to be the all-inclusive one, then there can be no appeal to outside sources for the illumination and interpretation of either the undefined primitive concepts or the concepts defined in terms of them.

In such a case it is possible only to deal with the system of ideas as a whole and to explore how that system derives meaning from the way in which it analyzes, categorizes, and organizes the elements of our experience. Whitehead continually contrasts his basic ideas with those of other philosophers; in fact, his exhibition of a basic difficulty in some classical system is his normal jumping-off point for the introduction of a new basic concept.

It is therefore fallacious to define Whitehead's basic concepts in the terms appropriate to other philosophers, because his conceptual reorganization is designed to avoid the shortcomings inherent in the older cosmologies. Instead, what we shall attempt here is a summary of the way in which Whitehead introduces the reader to some of his basic concepts, using only his own words as a guide.

EXPERIENCE

Whitehead defines speculative philosophy as 'the endeavor to frame a coherent, logical, necessary system of general ideas in terms of which every element of our experience can be interpreted' (pp. 567, 841). He identifies the meaning of 'experience' in the following paragraph (p. 845):

> In order to discover some of the major categories under which we can classify the infinitely various components of experience, we must appeal to evidence relating to every variety of occasion. Nothing can be omitted, experience drunk and experience sober, experience sleeping and experience waking, experience drowsy and experience wide-awake, experience self-conscious and experience self-forgetful, experience intellectual and experience physical, experience religious and experience sceptical, experience anxious and experience care-free, experience anticipatory and experience retrospective, experience happy and experience grieving, experience dominated by emotion and experience under self-restraint, experience in the light and experience in the dark, experience normal and experience abnormal.

The system of general ideas, or 'categoreal scheme,' is outlined in Chapter II of Process and Reality (pp. 584 ff.). The three basic notions of the scheme are introduced together in the following passage (p. 608):

The actualities constituting the process of the world are conceived as exemplifying the ingression (or 'participation') of other things which constitute the potentialities of definiteness for any actual existence. The things which are temporal arise by their participation in the things which are eternal. The two sets are mediated by a thing which combines the actuality of what is temporal with the timelessness of what is potential. The final entity is the divine element in the world, by which the barren inefficient disjunction of abstract potentialities obtains primordially the efficient conjunction of ideal realization. This ideal realization of potentialities in a primordial actual entity constitutes the metaphysical stability whereby the actual process exemplifies general principles of metaphysics, and attains the ends proper to specific types of emergent order. By reason of the actuality of this primordial valuation of pure potentials, each eternal object has a definite, effective relevance to each concrescent process. Apart from such orderings, there would be a complete disjunction of eternal objects unrealized in the temporal world.

In this passage we discern, first, the term 'actualities,' otherwise termed 'actual entities,' or 'actual occasions' or 'occasions of experience'; second, 'potentialities of definiteness,' otherwise termed 'eternal objects,' or 'pure potentials'; and, third, 'the divine element,' otherwise termed 'Deity' or 'God.' These are the three basic ideas in the general scheme. The interrelation of the three is expressed again in the following passage (p. 500):

The temporal world and its formative elements constitute for us the all-inclusive universe.

These formative elements are:

1. The creativity whereby the actual world has its character of temporal passage to novelty.
2. The realm of ideal entities, or forms, which are in themselves not actual, but are such that they are exemplified in everything that is actual, according to some proportion of relevance.
3. The actual but non-temporal entity whereby the indetermination of mere creativity is transmuted into determinate freedom. This non-temporal actual entity is what men call God—the supreme God of rationalized religion.

CREATIVITY (p. 588)

'Creativity' is the universal of universals characterizing ultimate matter of fact. It is that ultimate principle by which the many, which are the universe disjunctively, become the one actual occasion, which is the universe conjunctively. It lies in the nature of things that the many enter into complex unity.

'Creativity' is the principle of *novelty*.

GOD

For the introduction of the term 'God' consider the following passage on p. 572:

In all philosophic theory there is an ultimate which is actual in virtue of its accidents. It is only then capable of characterization through its accidental embodiments, and apart from these accidents is devoid of actuality. In the philosophy of organism this ultimate is termed 'creativity'; and God is its primordial, non-temporal accident.

God is identified on p. 873 as 'that factor in the universe whereby there is importance, value, and ideal beyond the actual.'

For further discussion of the term 'God' see especially pp. 492 ff. and 523 ff. The relation between the primordial nature of God and the consequent nature of God is explained in Chapter III of Part I of Process and Reality (pp. 599 ff.) and is developed in Part V of the same work.

ACTUAL ENTITY

The term is introduced on p. 585 as follows:

'Actual entities'—also termed 'actual occasions'—are the final real things of which the world is made up. There is no going behind actual entities to find anything more real. They differ among themselves: God is an actual entity, and so is the most trivial puff of existence in far-off empty space. But, though there are gradations of importance, and diversities of function, yet in the principles which actuality exemplifies all are on the same level. The final facts are, all alike, actual entities; and these actual entities are drops of experience, complex and interdependent.

A terse summary of the notion of actual entity is given in 'The Categories of Explanation,' beginning on p. 589.

CONCRESCENCE

The word Concrescence is a derivative from the familiar Latin verb, meaning 'growing together.' It also has the advantage that the participle 'concrete' is familiarly used for the notion of complete physical reality. Thus Concrescence is useful to convey the notion of many things acquiring complete complex unity. (P. 855.)

PREHENSION

The first analysis of an actual entity, into its most concrete elements, discloses it to be a concrescence of prehensions, which have originated in its process of becoming (p. 591).

The relation of prehensions to actual entities or actual occasions is explained in the paragraph entitled 'Prehensions' on pp. 799–800. Compare with this the following passage (p. 907):

Now as a first approximation the notion of life implies a certain absoluteness of self-enjoyment. This must mean a certain immediate individuality, which is a complex process of appropriating into a unity of existence the many data presented as relevant by the physical processes of nature. Life implies the absolute, individual self-enjoyment arising out of this process of appropriation. I have, in my recent writings, used the word 'prehension' to express this process of appropriation. Also I have termed each individual act of immediate self-enjoyment an 'occasion of experience.' I hold that these unities of existence, these occasions of experience, are the really real things which in their collective unity compose the evolving universe, ever plunging into the creative advance.

The term 'prehension' is introduced in the discussion on pp. 425–429. A similar introduction occurs on p. 852, where it is explained that the technical term 'prehension' stands to the common word 'apprehension' in the same relationship as the common word 'perception' stands to Leibniz's term 'apperception.'

'The Categories of Explanation' (pp. 589 ff.) sketch the use of the term, and Part III of Process and Reality develops the Theory of Prehension.

The basic kinds of prehension are introduced as follows (p. 591):

Prehensions of actual entities—i.e., prehensions whose data involve actual entities—are termed 'physical prehensions'; and prehensions of eternal objects are termed 'conceptual prehensions.' Consciousness is not necessarily involved in the subjective forms of either type of prehension.

. . . There are two species of prehensions: (a) 'positive prehensions' which are

termed 'feelings,' and (b) 'negative prehensions' which are said to 'eliminate from feeling.' Negative prehensions also have subjective forms. A negative prehension holds its datum as inoperative in the progressive concrescence of prehensions constituting the unity of the subject.

EVENT

Wherever and whenever something is going on, there is an event (p. 252).

This term plays the role in Whitehead's early work which is later played by the term 'actual occasion' or 'actual entity.' The terms are not synonymous, however, for they belong to two different kinds of thinking, as explained on pp. 201–202:

We are thinking 'homogeneously' about nature when we are thinking about it without thinking about thought or about sense-awareness, and we are thinking 'heterogeneously' about nature when we are thinking about it in conjunction with thinking either about thought or about sense-awareness or about both.

'Event' is the homogeneous term, and 'actual occasion of experience' or 'actual entity' the heterogeneous term.

For the relation of 'event' to 'prehension' consider the following passage on p. 429. The term 'prehension'

was introduced to signify the essential unity of an event, namely, the event as one entity, and not as a mere assemblage of parts or of ingredients. It is necessary to understand that space-time is nothing else than a system of pulling together of assemblages into unities. But the word *event* just means one of these spatio-temporal unities. Accordingly, it may be used instead of the term 'prehension' as meaning the thing prehended.

OBJECT

This term is common to both types of thinking, homogeneous and heterogeneous.

Objects are elements in nature which do not pass (p. 280).

This character of objects is called their 'eternality,' which is illustrated as follows (p. 422):

A colour is eternal. It haunts time like a spirit. It comes and it goes. But where it comes, it is the same colour. It neither survives nor does it live. It appears when it is wanted.

On p. 613 Whitehead compares eternal objects with Platonic forms; and on p. 623, with Locke's 'ideas.' He contrasts them with 'universals' on pp. 618 and 737. For a full discussion of the term consult the chapters 'Objects' (pp. 280 ff.) and 'Objects and Subjects' (pp. 798 ff.). Part II of The Principles of Natural Knowledge, not included in this anthology, is also important for a full study of the theory of 'objects.'

Some basic types of objects are: sense-objects (pp. 285, 315, and 427), perceptual objects (p. 288), physical objects (p. 289), and scientific objects (pp. 291 and 319). See also Chapter VII of The Principles of Natural Knowledge.

INGRESSION

This term denotes 'the general relation of objects to events' (p. 281) or 'the particular mode in which the potentiality of an eternal object is realized in a particular actual entity, contributing to the definiteness of that actual entity' (p. 590).

LAKE ERIE COLLEGE - LINCOLN LIBRARY
CIRC 192 W58, A2 N
Whitehead, Al Alfred North Whitehead :
3 0356 0005 1751 6

192 Whitehead
W58 Alfred North Whitehead
A2N 43581